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SPECIAL PUBLICATION NO. II
—
BRIEF HISTORY
OF
POLAR EXPLORATION
SINCE
THE INTRODUCTION OF FLYING

By W. L. G. JOERG
American Geographical Society

TO ACCOMPANY
A PHYSICAL MAP OF THE ARCTIC
AND
A BATHYMETRIC MAP OF THE ANTARCTIC



SECOND, REVISED, EDITION

AMERICAN GEOGRAPHICAL SOCIETY
BROADWAY AT 156TH STREET
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To accompany set of maps

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INTRODUCTION

SINCE 1925 we have been experiencing a revival of polar exploration. It is based on new tools, the airplane and the airship. Air-borne explorers avoid the obstacles of surface travel afoot, by sledge, or by boat. Not only that, but because of the altitude and speed of flight the area seen in a given period of time is enormously increased. What formerly took months of travel to accomplish is now done in hours, and the aerial mapping camera furnishes promptly the necessary specific record, which, with proper controls, can be transformed into a map.

In addition the radio provides a constant and immediate means of communication between an expedition and the outside world, thereby doing away with the long period of isolation hitherto the unavoidable lot of polar explorers and making known their discoveries to the civilized world almost as soon as they are made. This new facility of immediate contact has led to the growing practice of expeditions to sell the exclusive news rights to their wireless despatches from the field to a given newspaper or press syndicate. These despatches, of course, are the only contemporary accounts available, and they are often useful to the polar historian even after the final narrative of an expedition has been published, because they reflect the viewpoint of its members at the time and sometimes furnish specific details of value which later are no longer retained.

In order to make available for reference an up-to-date representation of these regions that are in the forefront of interest and to supply a means of following the work of the expeditions of the present new era of exploration, both in what they have already done and in what they are still going to do, the two polar maps accompanying this booklet have been prepared by the American Geographical Society. With the aid of these and a number of text maps we will first review the history of polar exploration since the introduction of flying, next briefly discuss the special methods of air navigation in the Polar Regions, then take up the present status of political sovereignty in the Arctic and Antarctic, and end with a description of the two maps and the major physical features which they display.

In this second, revised, edition (September, 1930) it has been possible to cover the entire season of 1929-1930 in the account of the Antarctic expeditions then in the field. This could not be done in the first edition, which carries the narrative only to January, 1930. Also, sections have been added dealing with the practical application of flying in the Arctic and with expeditions since 1925 not using aircraft for exploration.

HISTORY OF POLAR EXPLORATION SINCE THE INTRODUCTION OF FLYING

Antarctic Exploration

INASMUCH as the Antarctic has been the scene of the major sustained efforts in recent years (no less than six important expeditions in the last two field seasons; see Fig. 1), the following summary account of the main results achieved in polar exploration since the opening of the present period in 1925 will begin with that area.

EARLY PLANS FOR EXPLORATION FROM THE AIR

Prior to 1925 there were two Antarctic expeditions on which the use of aircraft was contemplated but not actually carried out.

Sir Douglas Mawson in 1911 acquired a Vickers monoplane with detachable, sledge-runner undercarriage for the Australasian Antarctic Expedition. But, meeting with an accident in Australia before the departure of the expedition, the plane was transported to the Antarctic without wings, to be used there as an air-tractor sledge. Even in this capacity it failed when put to the test in Adélie Land in 1912.

In 1920 a British Antarctic expedition, under J. L. Cope as leader (with Captain G. H.—now Sir Hubert—Wilkins as a member), planned to survey the King Edward VII Land area at the eastern entrance of Ross Sea and to reach the South Pole by airplane. Twelve airplanes had been acquired by gift from the Royal Air Force Disposal Board—old war-time stock; they were to be used in relays and more than half of them abandoned en route. However, the plans of the expedition had to be changed on account of lack of support, and the airplanes were returned to the Air Force.

WILKINS-HEARST EXPEDITION: FIELD SEASON OF 1928-1929¹

The Main Exploratory Flight

The first Antarctic expedition on which exploration was carried out from the air was that of Sir Hubert Wilkins in the region south

¹ Sir Hubert Wilkins: The Wilkins-Hearst Antarctic Expedition, 1928-1929, *Geogr. Rev.*, Vol. 19, 1929, pp. 353-376, with map in 1:6,000,000.



FIG. 1—Map showing the routes of the six major Antarctic expeditions of the field



seasons of 1928-1929 and 1929-1930, with dates of progress. Scale 1:58,000,000.

of the southern tip of South America (Fig. 1). Leaving Montevideo on October 24, 1928, on a Norwegian whaling steamer on which his two airplanes had been loaded, he reached his base, Deception Island in the South Shetlands (lat. 63° S.), via the Falkland Islands on November 6. After several preliminary local flights (that on November 16 being the first flight ever made in the Antarctic) Sir Hubert made his main exploratory flight on December 20, 1928, in a Lockheed Vega monoplane, with Lieutenant C. B. Eielson as pilot, to a point about 600 miles distant from Deception Island in a south-by-west direction. He returned by practically the same route. On this notable flight, in $5\frac{1}{2}$ hours, the duration of the outward journey, Sir Hubert demonstrated that what hitherto was thought to be a long, narrow peninsula projecting from the main body of the continent is, in reality, an archipelago. The land thus severed from the continent was seen to consist probably of at least two major islands—possibly more—divided in the latitude of the Antarctic Circle by a thoroughfare (Crane Channel), and of additional smaller islands to the south, the whole archipelago being separated from what is supposed to be the main mass of the continent (this part of which Sir Hubert named Hearst Land) by a wide strait in latitude 71° S., which he named Stefansson Strait. The major northern island is deeply indented by fiords on its eastern side: Hektoria Fiords ($64\frac{3}{4}^{\circ}$ S.), Evans Inlet ($65^{\circ} 10'$), and Richthofen Valley ($65^{\circ} 50'$). The eastern side of the southern island is occupied by the Lockheed Mountains in its northern half and Bowman Coast in its southern. Then southwards follow smaller islands decreasing in size, the last group before reaching Stefansson Strait having been named Finley Islands.

The whole area, therefore, turns out to be a mass of islands, large and small, and it is suggested on the accompanying map of the Antarctic to term it the Antarctic Archipelago. Conceived as a peninsula it has generally been known heretofore as Graham Land, although even this designation was an extension of the name applied originally in honor of the then First Lord of the British Admiralty to the land discovered by Biscoe in 1832. Biscoe discovered many of the offshore islands along the west coast between latitudes 68° and 64° , taking some of them, however, to be part of the mainland.

New Light on Ice Conditions in Weddell Sea

Most of Wilkins' flight paralleled the eastern side of the Antarctic Archipelago and seems to confirm the continuation immediately southward, along this side, of the shelf ice,² or sheet of floating ice attached to the shore, whose northern end Otto Nordenskjöld, leader of the Swedish Antarctic Expedition of 1901-1903, had found to begin in latitude $64\frac{1}{2}^{\circ}$. Whether this shelf ice borders the whole length of the unknown, conjectured southwestern shore of Weddell Sea until it joins the shelf ice found by Filchner in 1912 at the apparent head of that sea, or whether the observed stretches are local phenomena, are moot questions. Wilkins' discovery of Stefansson Strait establishes the existence of a possible outlet for the ice of Weddell Sea and hence favors the view that this shelf ice does not form a continuous barrier.

That ice from Weddell Sea occasionally may discharge through this outlet seems indicated by a number of occurrences. The rotary, clockwise current system of that sea tends to drive the drift ice against its western side, which is therefore normally blocked. But the remarkable freedom from ice in 1823 which permitted Weddell to advance to $74^{\circ}15'$ near the head of the sea (also, probably, Morrell three weeks later to $70^{\circ}14'$) and Larsen in 1893 to $68^{\circ}10'$, close to its western shore, might indicate that much of the ice had escaped through this outlet in those years. The finding by the Norwegian whaler *N. T. Nielsen-Alonso*, in the season of 1928-1929, of a dead blue whale floating in Ross Sea with a harpoon embedded in its body that clearly indicated it had been struck in Weddell Sea³ is a piece of recent evidence that may point to occasional open communication between Weddell Sea and Bellings-

² On the nature and origin of shelf ice see C. S. Wright and R. E. Priestley: *Glaciology* (Sci. Results British Antarctic Exped. 1910-1913), London, 1922, pp. 161-169 and 205-222. Two types are there distinguished, one formed originally by the outward extension of land ice and the other by the accumulation of snow upon persisting sea ice. The shelf ice bordering the western side of Weddell Sea probably belongs to the second type; the classical example of the first type is the Ross Shelf Ice at the head of Ross Sea. Priestley (*op. cit.*, p. 162) accepts the term shelf ice, originally proposed by Otto Nordenskjöld and also employed by Drygalski, as the best generic name for this form of ice, rather than a term derived from the designation "ice barrier" applied by Sir James Ross on discovering in 1841 the great ice sheet that now bears his name. That term envisaged it as an obstruction to navigation and furthermore, strictly, referred only to its seaward cliff face. In keeping with Priestley's usage the term shelf ice is made a part of the proper name of each of the various occurrences of this phenomenon shown on the present map of the Antarctic, e.g. Ross Shelf Ice instead of Ross Barrier, Filchner Shelf Ice, etc.

³ Despatch from Hobart, Tasmania, *New York Times*, Feb. 20, 1929.

hausen Sea to the westward, whence the existing westerly inshore current would in the present case account for the rest of the drift to Ross Sea.

The Secondary Flight

A second flight by Wilkins, on January 10, 1929, 250 miles out on practically the same course, confirmed the observations of the previous flight and completed the season's field work. After storing his two airplanes and supplies there Sir Hubert left Deception Island at the end of January, 1929, for New York via the west coast of South America, to return south in time to resume his work in the field season of 1929-1930.

WILKINS-HEARST EXPEDITION: FIELD SEASON OF 1929-1930⁴

Returning to South America in October, 1929, Sir Hubert Wilkins sailed from Montevideo on November 1 and arrived at Deception Island on November 11. He there found all his supplies and his two Lockheed planes in good order. The weather, however, was not as favorable as the previous season, and hence he decided to establish his base farther south. Loading one Lockheed plane on the *William Scoresby*, one of the vessels of the Discovery Committee conducting oceanographical and whaling investigations in the South Atlantic⁵ that had been placed at his disposal by the British Colonial Office, Wilkins proceeded southwestward among the outer islands of the Antarctic Archipelago and through Bismarck Strait out into the open Pacific to a point in about $67\frac{1}{2}^{\circ}$ S. and $70\frac{1}{4}^{\circ}$ W., abreast of the southern part of Adelaide Island, where it had been hoped to find ice suitable for a take-off. But no such ice was found, and the vessel returned to Neumayer Channel, where Port Lockroy ($64^{\circ} 50' \text{ S.}$ and $63^{\circ} 29' \text{ W.}$) was reached on December 17.

⁴ Sir Hubert Wilkins: Further Antarctic Explorations, *Geogr. Rev.*, Vol. 20, 1930, pp. 357-388, with map in 1:6,000,000.

⁵ The first-fruits of the work of this committee are the series of "Discovery Reports" it began to publish in 1929, of which "Discovery Investigations: Objects, Equipment, and Methods," by S. Kemp, A. C. Hardy, and N. A. Mackintosh (Vol. I, pp. 141-232) and the oceanographical "Station List" (Vol. I, pp. 1-140) may be mentioned here. The oceanographical and biological observations made on the Wilkins cruises of the *Scoresby* will be published later in this series. For an earlier general account of the work of the committee see A. C. Hardy: The Work of the Royal Research Ship "Discovery" in the Dependencies of the Falkland Islands, *Geogr. Journ.*, Vol. 72, 1928, pp. 209-234.

Flight Across Main Island of Antarctic Archipelago

On December 19 Wilkins succeeded in making a three hours' flight, taking off from the southern end of Neumayer Channel, thence flying south along the coast to Beascochea Bay ($65\frac{1}{2}^{\circ}$), where he crossed the 9000-foot plateau to its eastern side at Richthofen Valley, a deep indentation that he had seen a year before, and returning to his starting point. The flight confirmed the position of the eastern coast as derived from dead reckoning the previous year.

Flight Around Charcot Island

Although still prevented by spells of unseasonable weather and unfavorable ice conditions from finding a suitable base from which to start on the proposed major flight along the unknown coast to Ross Sea, Wilkins on December 29, 1929, was able to make an important four-hour flight of about 450 miles which seems to establish the continuation for at least 300 miles farther westward of the coast of the continental mainland (Hearst Land) discovered a year before (see the map of the Antarctic). Having substituted pontoons for wheels on his plane he took off from the water alongside the *William Scoresby*, whose position was $67^{\circ} 47' \text{ S.}$ and $75^{\circ} 21' \text{ W.}$, with S. A. Cheesman as pilot. Flying due south, he reached the coast of Charcot Island (whose insular character was confirmed) in 1 hour and 20 minutes. (On a flight two days before, December 27, Wilkins had already reached a point near by, only to be balked by an impenetrable snowstorm and forced to return to the ship.) The island was discovered in January, 1910, on the Second French Antarctic Expedition under Dr. Charcot, but as only one side was seen its true nature could not be determined and it was named Charcot Land. The general configuration of land in the known areas to the northeast has for some time made it seem probable that it is an island, but until Wilkins' flight this assumption lacked confirmation. Wilkins found Charcot Island to be 60 miles long east-west (capes in $70\frac{1}{4}^{\circ} \text{ S.}$ - $73\frac{3}{4}^{\circ} \text{ W.}$ and 70° S. - 76° W. were named Capes Mawson and Byrd) and 40 miles north-south: the highest elevation is about 2000 feet. Nearly two hours were spent in circling the island. Eastward could be seen two new islands. They appeared to lie be-

tween latitudes $69\frac{1}{2}^{\circ}$ and $70\frac{1}{2}^{\circ}$ S. The northerly or larger island seemed to be about 30 miles long, crossing latitude 70° S. between the 68th and 69th meridians. These two new islands may represent western members of the Finley Islands, discovered the year before, north of Stefansson Strait. Low, level sea ice interspersed with icebergs could be seen to continue through the strait; this would seem to bear out the theory that an open channel exists here (see above, p. 7). To the south of Charcot Island a low, sloping, snow-covered coast, broken here and there by bare peaks, was seen to continue westward to longitude 80° W. It is of the same character as the coast of Hearst Land and is evidently a continuation of it; also, as this is the aspect typical of the margin of the Antarctic Continent in most of its known segments, it is not unreasonable to assume that Wilkins has located another piece of its circumference.

On January 5, 1930, Wilkins returned by airplane to Deception Island. The *Scoresby*, from which he had flown, reached there a few hours later.

It now became necessary for the *Scoresby* to reprovision and refuel, and with the permission of the Colonial Office in London it was arranged that, after having done this at the Falkland Islands, she should return immediately so that Wilkins might make another foray to the west.

Southward Flight in 101° W.

The *Scoresby* returned to Deception Island on January 25 and immediately started west again. On this trip she advanced for no less than 1200 miles, which took her 250 miles beyond Peter I Island, past which her course lay about 50 miles to the south. The *Scoresby* having reached a point in about $69\frac{2}{3}^{\circ}$ S. and nearly 100° W. on January 30, a short flight was attempted, but snow squalls made an immediate return to the vessel imperative.

Two days later, on February 1, when the vessel was in $70^{\circ} 10'$ S. and $100^{\circ} 45'$ W., the weather had cleared sufficiently to permit another flight. A quick dash was made for a distance of 200 miles, which brought the estimated position of the plane to 73° S. on about the 101st meridian. Nothing was seen but pack ice, although towards the extreme end of the flight the ice was more compact.

The soundings of the *Belgica* in 1899, which showed depths of 400 and 500 meters in latitude 71° S., might lead one to assume that land lay not far to the south. Wilkins' flight seems to show that the continental shelf here is very wide, possibly constituting a platform fronting an archipelago or broken land mass of whose existence the northeastern trend of the land discovered on Byrd's flight of December 5, 1929 (see p. 15) and the known impenetrability by ship of the area between the locations of Wilkins' and Byrd's flights may also be indicative.

After the plane had successfully found the *Scoresby*—not an easy task—the expedition started on its return to Deception Island. On the return route two southward advances were made by the ship, one in longitude 88° W. and another in 82° W., for oceanographical work. The *Scoresby* finally reached Deception Island on February 14, and Sir Hubert Wilkins sailed on that day for Montevideo.

BYRD ANTARCTIC EXPEDITION OF 1928-1930⁶

The expedition headed by Rear Admiral Richard E. Byrd was on a large scale. It comprised over 80 men all told, of whom 42 constituted the group that remained in the Antarctic during the fourteen months of the expedition's sojourn there. Two vessels transported the party and its equipment. The *City of New York* left New York on August 25, 1928, followed by the *Eleanor Bolling* on September 16. Going via the Panama Canal the vessels met at Dunedin, New Zealand. Thence they proceeded on December 2 to Ross Sea (Fig. 1), the *Eleanor Bolling* turning back from the neighborhood of the Scott Islands and the *City of New York* reaching the edge of the Ross Shelf Ice in longitude $177^{\circ} 25'$ W. on December 25. On December 28 the site for the base was selected in the Bay of Whales about 125 miles farther east, in the neighborhood of Framheim, Amundsen's base in 1911. Houses and huts

⁶ R. E. Byrd: *The Conquest of Antarctica by Air*, *Natl. Geogr. Mag.*, Vol. 58, 1930 (August), pp. 127-227, with map of flights, 1:10,000,000, on p. 132, and remarkable photographs; W. L. G. Joerg: *The Work of the Byrd Antarctic Expedition, 1928-1930*, Amer. Geogr. Soc., New York, 1930 (January), with map of flights in 1:6,000,000 and map of ship's routes and soundings between New Zealand and the Antarctic, 1:12,000,000 (text based, with permission, on the despatches from the expedition in the field that appeared in the *New York Times*). Although each of these two accounts supplies a summary of the whole expedition, some field despatches are cited in the present narrative for certain details these accounts do not contain.

were erected forming a complete wintering station. It was christened Little America. The three airplanes that made up the flying equipment of the expedition, a Ford trimotor, a single-motored Fokker, and a single-motored Fairchild, all monoplanes, were safely unloaded. A wireless sending and receiving station was set up which from the first maintained an almost unbroken communication with civilization and with the expedition's airplanes while in flight.

Preliminary Flights at End of Field Season of 1928-1929

What still remained of the southern summer was utilized to undertake a number of exploratory flights. On January 27, 1929, a triangular flight was carried out to the northeast and east of Little America. The first leg, to the northeast, led as far as the Alexandra Mountains (seen by Scott from the sea in 1902), and observations indicated the possibility that King Edward VII Land may be an island separated by a channel from the mainland. In flying thence south a new range was discovered in the shape of a crescent whose concave side faced northwest and whose ends were later fixed as lying respectively in $78^{\circ} 14' \text{ S.}-155^{\circ} 15' \text{ W.}$ and $77^{\circ} 35' \text{ S.}-153^{\circ} 5' \text{ W.}$ This range was named the Rockefeller Mountains.

On February 18 another flight was made with two planes, one flown by Admiral Byrd and the other by Captain A. B. Parker (Fig. 1). After a flight of 70 miles northeast from Little America, the course was then set southeast to pass about 15 miles south of the Rockefeller Mountains. About 70 miles east of these mountains lay a conspicuous, isolated 5000-foot peak whence an imposing range was seen to run in a southeasterly direction and to extend beyond the 150th meridian W. into land which was named Marie Byrd Land. As this lies outside of the British territory of the Ross Dependency, it was claimed for the United States. On the same day another flight was made by Captain A. C. McKinley over much the same ground with the aerial mapping camera. From his vantage point he estimated the peaks of the southeast-trending range to be 8000 feet high.⁷

⁷ *New York Times*, Feb. 21, 1929.

His interest aroused by the discovery of the Rockefeller Mountains, Dr. Laurence Gould, geologist of the expedition, made arrangements to visit the range in spite of the approaching winter season. On March 7 he flew there with Bernt Balchen, pilot, and Harold June, radio operator. After a few days of very satisfactory work a violent storm blew the plane from its moorings, wrecking it completely and cutting off radio communication. Byrd, with Dean Smith as pilot and Malcolm Hanson as radio operator, flew to the rescue on March 18. Balchen, Smith, and June flew back to Little America the same day, leaving Byrd, Gould, and Hanson at the camp at the Rockefeller Mountains. On March 22 Smith and June flew from Little America to the camp and finally brought home the other three men. It was on this excursion that Dr. Gould determined the previously mentioned astronomic position of the Rockefeller Mountains. The camp lay in $78^{\circ} 9' \text{ S.}$ and $154^{\circ} 27' \text{ W.}$ The peaks, all heavily flanked with snow and some completely smothered in it, range in height from about 500 feet to more than 2000 feet above sea level. The snow surface about the mountains averages 300-400 feet above sea level. The Rockefeller Mountains are, like the Alexandra Mountains, composed of granites (probably Precambrian) and associated rocks.⁸

The Flight to the South Pole

The Antarctic winter now enforced inactivity. But with the approach of milder weather preparations were made for the major distance flight of the expedition. On November 18, 1929, Byrd made a preliminary flight of about 440 miles from Little America along the 163rd meridian to the foot of the mountains that rim the South Polar Plateau. A base of food and gasoline was laid there. The return trip was made the next day. The experience of this flight seems to show that the eastern limit of the Ross Shelf Ice may lie about 100 miles farther east than hitherto assumed and that there is no land east of the route of the flight where Amundsen indicated an "appearance of land" in $81\frac{1}{2}^{\circ} \text{ S.}$ At the mountains it was apparent that the scarp front of the plateau continued in a southeastern direction from Axel Heiberg Glacier, and

⁸ *ibid.*, March 10, 25, 26, and June 16, 1929.

it therefore seemed that Carmen Land as represented on the map⁹ accompanying Amundsen's account of his South Pole journey does not exist.¹⁰

Finally, on November 28 and 29, 1929, with Bernt Balchen (pilot with Byrd on his transatlantic flight) and Harold June as pilots and Captain A. C. McKinley operating the surveying camera, the 1600-mile flight to the South Pole and back (Fig. 1) was successfully carried out in 19 hours, including a stop of one hour at the refueling base. Byrd is thus the first to attain the South Pole by air, and the only man to have flown to both North and South Poles. The outward route over the Ross Shelf Ice practically duplicated Amundsen's, but in the difficult climb up to the plateau Liv Glacier, next west of Axel Heiberg Glacier, was followed and thence approximately the 172nd meridian to the Pole, which was reached on November 29 at 1.25 P. M., Greenwich mean time. Soon after the rim of the plateau was passed, new mountains were seen to the right, i.e. in the west, whose peaks did not project much above the ice cap. These may be inner members of the broad belt of spurs and ridges in which the plateau breaks down to the shelf ice. The return from the Pole followed Amundsen's return route down Axel Heiberg Glacier and then, after an hour's stop at the base established on November 18, a straight line for Little America. Aerial photographs were made of the whole journey.¹¹

The new technique introduced through aerial mapping and constant communication by radio was well illustrated by this flight. From Dr. Gould's geological party, which had started by sledge on November 4 for the foot of the mountains and had by that time advanced 408 miles from Little America, Admiral Byrd received a report of the weather in that locality which, combined with a knowledge of the weather at the base, gave him a clue as to what to expect on the polar plateau. Conversely, Byrd, on reaching Gould's party, dropped a package of photographs of the mountains taken on the base-laying flight which were of great value to Gould in helping him to plan the best methods of attack on the geological problems presented.

⁹ See, below, footnote 16.

¹⁰ *New York Times*, Nov. 20, 21, and 22, 1929.

¹¹ *New York Times*, Dec. 2, 3, 4, 1929.

Exploratory Flight Northeast of Little America

Finally, on December 5, Byrd made another flight northeast of Little America (Fig. 1). On this he went much beyond his previous farthest in this direction and discovered that the coast line trended north-northeast at least to latitude 74° in longitude 145° , whence it may again recede to the eastward or may continue still farther northeastward. The coast seemingly forms the outer eastern flank of Ross Sea and accentuates its reëntrant character. The shore itself is skirted with a belt of shelf ice in which ice-islands are embedded. Some distance inland a mountain range of great length and in some places of 10,000-foot height was discovered. It runs approximately north-south about in longitude 143° W. and seems to extend north beyond 74° S. and south at least as far as 79° S. At its foot, between the range and 150° W., lies a belt of land, the southern part of which represents the Marie Byrd Land of the February 18 flight, but to the whole of which the name may appropriately be applied. Into this land glaciers from the range debouch. The range may be a scarp front rather than a two-slope range, but as it was only seen and photographed from a parallel course 80-100 miles to the west it is not possible to say. On the return the plane flew close to the Matterhorn, the isolated conspicuous 5000-foot peak seen on the February 18 flight (about $77\frac{1}{2}^{\circ}$ S. and 150° W.). Near it was found a remarkable series of non-frozen small bodies of water imprisoned in depressions in the shelf ice.¹²

These discoveries have twofold significance, physical and political.

Physically the northward trend of the coast and the occurrence of ice-island-dotted shelf ice may explain why the region off the eastern entrance to Ross Sea has remained impenetrable, no vessel having entered the area defined by the tracks of Ross and Cook, i.e. roughly east of 160° W. and south of the Antarctic Circle. A northward projection of the coast in this region, either as a continuous body of land or as an archipelago, would tend to concen-

¹² *New York Times*, Dec. 7, 1929; *Natl. Geogr. Mag.*, Vol. 58, 1930, pp. 219-220, map on p. 132, and photographs on pp. 181 and 222.

trate and hold the pack ice in this area—all the more so as it would act as a dam to the westward longshore drift of the ice.

Politically the discovery is of significance because it creates, east of the 150th meridian and hence outside of British territory, a coastal access to and continuity with inland territory (Marie Byrd Land) previously claimed for the United States. The validity of this claim might have been questioned if it had been based on access from foreign territory only.

The Work of the Geological Sledge Party

Though aerial photography has provided the explorer with a technique of the highest value, ground work is still indispensable in geological surveying, as well as in most other phases of field work. Admiral Byrd is second to no one in the recognition of this truth. "I believe," he has said,¹³ "that for exploration work in the Arctic [and Antarctic] an expedition that combined dog teams and aircraft would be most effective." He was fortunate in securing as geologist of the expedition Dr. Laurence M. Gould, professor of geology at the University of Michigan, who had already had polar experience on the first Greenland Expedition of the University of Michigan, 1926 (see p. 44), and on the Putnam Baffin Island Expedition of 1927 (p. 54).

To supplement the polar flight a geological sledge expedition to the mountain border of the South Polar Plateau was included in the program. The route across the Ross Shelf Ice between Little America and the mountains lay along the 163rd meridian W. Four depots with food and supplies were established beforehand along this route, one every 50 miles in the first 200 miles from Little America, and a cache had been left by Byrd at the foot of the mountains on his preliminary base-laying flight on November 18-19 (see above, p. 13). On November 4, 1929, as stated above, the start was made from Little America, the party consisting of Dr. Gould and five other men. The 440 miles to the mountains were covered in twenty-eight days, the last two daily marches amounting to 26 and 40 statute miles respectively. Arriving at

¹³ R. E. Byrd: *Polar Exploration by Aircraft*, in "Problems of Polar Research," *Amer. Geogr. Soc. Special Publ. No. 7*, 1928, pp. 381-394; reference on p. 387.

the foot of Liv Glacier on December 1 the party attempted to reach the plateau by way of this glacier but was forced to desist because of the intensive crevassing. Establishing camp on Axel Heiberg Glacier in $85^{\circ} 2' \text{ S.}$ and $165^{\circ} 30' \text{ W.}$ at a point just west of Amundsen's Mount Betty, Gould on December 7 ascended the slope of Mount Nansen, which lies between Liv and Axel Heiberg Glaciers, to a height of 6500 feet. Here he was rewarded by finding the exposed rock to consist of a sandstone with a layer of highly carbonaceous material, which he is sure is the so-called Beacon sandstone. In commenting on the significance of this find Professor Griffith Taylor¹⁴ of the University of Chicago, formerly senior geologist and leader of the western parties of the British Antarctic Expedition of 1910-1913 under Scott, points out that other exposures of this horizontally stratified formation occur, generally at the heads of breaching glaciers along the face of the South Victoria Land *horst*, or uplifted crustal block, throughout its whole extent, from the Larsen Glacier (75° S.), the Mackay Glacier (77° S.), and the Ferrar and Taylor Glaciers (78° S.), to the Beardmore Glacier (85° S. and 165° E.). The discovery, therefore, of Beacon sandstone on Mount Nansen (85° S. and 168° W.) extends its known range and makes it all the more probable, as suggested by Sir Edgeworth David of the University of Sydney, Australia, dean of Antarctic geologists, that the coal with which this formation is associated underlies the ice-capped South Polar Plateau back of the *horst* in the form of a vast coalfield some 100,000 square miles in extent.¹⁵

On December 13, after having found Byrd's cache on the day before, the geological party started from the camp near Mount Betty on a side trip that led east-southeast about 110 miles to a point in $85^{\circ} 27' \text{ S.}$ and $147^{\circ} 30' \text{ W.}$ This was both outside of the Ross Dependency and well within Carmen Land as represented by Amundsen. Politically the area was claimed for the United States. Geographically it was demonstrated that the scarp front of Carmen

¹⁴ *New York Times*, Jan. 3, 1930, with block diagram of the Ross Sea area. On the significance of the Beacon sandstone see also R. E. Priestley and C. E. Tilley: Geological Problems of Antarctica, in "Problems of Polar Research," *Amer. Geogr. Soc. Special Publ. No. 7*, 1928, pp. 315-328; reference on pp. 318-319.

¹⁵ *New York Times*, Dec. 5, 9, 1929, Jan. 3, 1930.

Land, shown on Amundsen's map¹⁶ as running southwest-northeast athwart the possible head of the Ross Sea, does not exist. Instead, as first assumed from what was seen on Byrd's base-laying flight of November 18-19 (see above, p. 13), low shelf ice extends southeastward at least as far as the 140th meridian W. along the outer flank of the Queen Maud Range. (This, as Gould and Griffith Taylor observe, makes it incumbent to give renewed attention to the theory of a low-depression connection between Ross and Weddell Seas.) Amundsen necessarily only saw the inner flank, and in thus tracing the outer flank and its bordering shelf ice both Byrd and Gould take pains to state that their findings cast no reflection on Amundsen's work, since from his route on the ground these features were hidden from him, and that as to the Carmen Land scarp he may have mistaken enormous pressure ridges for snow-capped mountains. For, indeed, as Gould reports, the crevassing of the shelf ice along the outer margin of the Queen Maud Range in this area is on a gigantic scale. The outer members of the range are relatively low as compared with the same features in the more northerly sections of the range; they are hence unable to hold back the ice on the plateau effectively, and it pours down on the shelf ice in enormous volume, causing that sheet to buckle and form great pressure ridges.

On Christmas Day the party was again back at its camp near Mount Betty. On passing that mountain and examining closely a curious rock pile on one of its low ridges Gould discovered the cairn that Amundsen had erected on January 6, 1912, on his return from the South Pole. The contents—a ten-liter can of kerosene, two packages of matches, and a brief note by Amundsen telling of the work of the expedition—were found in excellent condition. Amundsen's note was replaced by a statement of the find and by a brief account of the Byrd expedition and the work of the geological party, and the cairn was rebuilt just as Amundsen had left it eighteen years before. On December 31, 1929, the home-

¹⁶ Chart of the Antarctic Region between Latitudes 75° S. and 90° S. and Longitudes 100° W. and 150° E., [1:5,250,000], at end of Vol. 2 of Amundsen's "The South Pole," 2 vols., London and New York, 1913 (shows the scarp front but lacks the name Carmen Land; the corresponding map accompanying the German edition of the book, Munich, 1912, bears the name, however). On the development of Amundsen's conception of Carmen Land, see footnote on p. 56 of second work cited in footnote 6 above.

ward journey was begun, and the party arrived safely back at Little America on January 19, 1930.

Last Flights and Return of the Expedition

The work of the expedition was now rapidly drawing to a close. Three last flights were made: one on January 20, 1930, westwards to Discovery Inlet, an indentation in the Ross Shelf Ice front; another on January 21 southwestward into the interior of the shelf ice; and the third in the vicinity of Little America. The second flight, on which the farthest point reached was in $80^{\circ} 45' \text{ S.}$ and $172^{\circ} 30' \text{ W.}$, is important as being the only penetration of the central part of the Ross Shelf Ice between Scott's and Amundsen's routes to the pole except for Lieutenant Royds's sledge expedition in November and December, 1903, during the British Antarctic Expedition of 1902-1904 under Scott, on which the farthest point reached lay in $79^{\circ} 33' \text{ S.}$ and 176° E. ¹⁷ At Byrd's farthest there was a pressure-ridge area of considerable magnitude, from which two members of the flight were certain they saw rock protruding. "If there is land at that point, it is one of four known points where land is apparently holding back the Barrier, the others being at the Bay of Whales, the crevasses south of the bay at $81^{\circ} 10' \text{ S.}$, and Discovery Inlet."¹⁸

The two vessels of the expedition, the *City of New York* and the *Eleanor Bolling*, were now proceeding southward to take home the members of the expedition, the former having left Dunedin, New Zealand, on January 5 and the latter on January 20. The unusual width (400 miles), however, and persistence of the pack ice off the entrance to Ross Sea made the passage extremely difficult—indeed, for the *Eleanor Bolling*, impossible, forcing her to turn back north at about the Antarctic Circle. Finally, after having been swept westward by storms to within sight of Mount Erebus, the *City of New York* reached Little America on the evening of February 18. By 9.30 A. M. the following morning all the material had been put on board (except the two airplanes, which had to be

¹⁷ National Antarctic Expedition, 1901-1904: Charts by Lieut. G. F. A. Mulock, London, 1908; reference on Chart of the Antarctic Ocean, [1:725,000], Sheet 2.

¹⁸ Byrd in *Natl. Geogr. Mag.*, Vol. 58, 1930, p. 223.

left behind owing to the inability of the *Eleanor Bolling* to get through), and the expedition departed finally from the scene of their labors of fourteen months. Dunedin was reached on March 10. After the members of the expedition had enjoyed several weeks of rest among the hospitable people of New Zealand the two vessels set sail for home, the *City of New York* on March 23 and the *Eleanor Bolling* on April 1. The return across the Pacific and via the Panama Canal was necessarily slow because of the relatively low normal speed of the vessels, so that New York was not reached until June 19, 1930, soon after which the expedition was officially disbanded.

NORWEGIAN EXPLORATION: EXPEDITIONS OF 1926-1929

To the modern whaling industry, based on the revival of value of whale oil brought about by its use in the manufacture of soap and oleomargarine, is to be ascribed a series of important Norwegian expeditions to the Antarctic, beginning in the season of 1926-1927 and culminating in the 1929-1930 expedition under the command of Riiser-Larsen, the geographical results of which stamp it as one of the major Antarctic expeditions of recent times.¹⁹ The earlier of these expeditions, although less well known, are also quite remarkable, because of the distances covered in Antarctic waters and the continuity and persistence of their activities.

The whaling industry in the Antarctic is mainly in the hands of Norwegians, but the establishment of the Falkland Islands Dependencies and the Ross Dependency—including, as they do, most of the hitherto known whaling grounds—coupled with the British policy of requiring a license fee from all operating from shore stations on the islands and other territories of these dependencies, has led to the development by the Norwegians of pelagic whaling and to their search for bases outside of British control.

¹⁹ Bjarne Aagaard: Fangst og Forskning i Sydishavet (Whaling and Exploration in the Antarctic Ocean), Oslo, in press, with map showing routes of expeditions, 1:37,000,000.

Bjarne Aagaard: Antarctic Whaling and Exploration, *Scottish Geogr. Mag.*, Vol. 45, 1929, pp. 23-34 and 65-81.

Olaf Høltedahl: On the Geology and Physiography of Some Antarctic and Sub-Antarctic Islands (Scientific Results of the Norwegian Antarctic Expeditions, 1927-1928 and 1928-1929, instituted and financed by Consul Lars Christensen, No. 3), Norwegian Acad. of Sci., Oslo, 1929.

Gunnar Isachsen: Modern Norwegian Whaling in the Antarctic, *Geogr. Rev.*, Vol. 19, 1929, pp. 387-403.

Pelagic whaling consists in the working up as well as the capture of the whale in the open sea and involves the use of a new type of vessel, the "floating factory" equipped with a slipway in stern or bow by which the whale can be taken bodily on board for dismemberment. The search for bases outside of British sovereignty led to the recent annexation of Bouvet Island, south of Africa, by Norway on December 1, 1929, and Peter I Island, south of South America, on February 2, 1929. Both islands are strategically located with reference to the whaling grounds.

The chief sponsor of scientific expeditions to help the whaling industry is Consul Lars Christensen of Sandefjord, Norway. In the last four Antarctic summer seasons he has sent out no less than five expeditions.

In 1926-1927 the *Odd I* was sent to South Georgia, the South Shetlands, and Peter I Island. In the season of 1927-1928 the *Norvegia* visited Bouvet Island, the South Sandwich Islands, and South Georgia.

The 1928-1929 work of the *Norvegia* (Fig. 1) was of much importance, as her cruise extended through two-fifths of the circumference of the globe in these latitudes, namely from Bouvet Island (4° E.) to 140° W. On a westward leg between Peter I Island and 130° W. she outlined the outer edge of the pack ice in February, 1929, for about 500 miles roughly along the 70th parallel, in a sector in which its inner edge was not reached even in 73° S. on Wilkins' flight to that latitude a year later (see p. 10). On her subsequent eastward course along the 60th parallel the *Norvegia* made a detour in about longitude 98° W. to search for conjectural Dougherty Island in some of its reported positions.

Also in 1928-1929 another vessel, the floating factory *Thorshammer*, operated in the neighborhood of Bouvet Island, making a high southerly advance beyond the Antarctic Circle in longitude 10° E.

NORWEGIAN EXPLORATION: RIISER-LARSEN EXPEDITION OF 1929-1930

The expedition of 1929-1930 under Commander Riiser-Larsen on the *Norvegia* actually started on November 8, 1929, at a point

west of Bouvet Island in 55° S. and 4° W. (Fig. 1.).²⁰ Here the *Norvegia*, which in October had left South Georgia, where she had been laid up during the southern winter, was met by the *Thorshammer*, which transferred to the *Norvegia* the expedition's equipment, including two airplanes, a Lockheed Vega monoplane and a naval reconnaissance seaplane loaned by the Norwegian Navy. The personnel of the expedition consisted of Commander Riiser-Larsen, in command; Commander Lützow-Holm, a well-known pilot of the Norwegian Naval Air Service and Riiser-Larsen's comrade on many flights; Captain Nils Larsen; and fifteen other members, including the crew.

The *Norvegia* first proceeded to Bouvet Island, where she had been a short time before to establish a shelter and provision depot for shipwrecked mariners. Bouvet Island was photographed from the air and disclosed as an ice-clad crater.

The next goal of the expedition was Enderby Land (about 50° E. on the Antarctic Circle) discovered by Biscoe in 1831. Taking into account the earliness of the season and the fact that the pack-ice edge would consequently probably lie relatively far north, together with the known westerly direction of the current along the coast of the Antarctic Continent in this area, Riiser-Larsen, instead of proceeding directly to Enderby Land, shaped his course eastwards (with as much southing as the pack ice would permit) with the intention of striking inwards to the south in about the longitude of Enderby Land. In this reasoning he was confirmed by the experience of the German *Valdivia* expedition of 1898 which, in December, found a deep reëntrant in the pack ice at about 53° E. with open water beyond the 64th parallel.

Mapping of the West Coast of Enderby Land and Discovery of Adjoining Queen Maud Land

The estimate of ice conditions proved correct, and early in December the *Norvegia* was able to advance southward about on the 54th meridian, reaching a position in $64^{\circ} 21'$ S. and $53^{\circ} 14'$ E.

²⁰ Hjalmar Riiser-Larsen: The "Norvegia" Antarctic Expedition of 1929-1930, *Geogr. Rev.*, Vol. 20, 1930, pp. 555-573, with map, 1:25,000,000 (insets 1:6,000,000). Despatches from the expedition in the field appeared in the Oslo newspaper *Tidens Tegn*, Dec. 28, 1929, Jan. 17, Feb. 4, 18, 21, 27, March 4, 1930, and the *New York World*, Feb. 14, 21, 28, 1930.

on December 7. From this locality the first flight was made to a point 40 miles south. Here, from an elevation of 4000 feet, land was seen. Two black rock masses were visible, and the coast was seen to extend east and west from them. Far to the east what seemed to be a mountain range appeared above the ice, and several nunataks were observed far inland, where the inland ice gradually rose to the south. The rock masses seen must have been in the vicinity of Proclamation Island, visited by Sir Douglas Mawson five weeks later (see below, p. 32). Flying back to a point near the ship, Riiser-Larsen continued in a southwestward direction for an hour to observe the condition of the pack ice and then returned on board the *Norvegia*.

Continuing southwest the *Norvegia* reached $65^{\circ} 15' \text{ S.}$ and $49^{\circ} 30' \text{ E.}$ on December 22 (Fig. 2). From here the second flight was made in a south-southeastward direction. In 105 miles the coast was reached not far from a conspicuous bare rocky headland which was taken to be Biscoe's Cape Ann. This was rounded and the flight continued for twenty-five minutes, when the airplane was brought down in open water and taxied for a short distance over the smooth coast ice, which here was only half a foot above the water. The cliff face of the inland ice, about 60 feet high, was quite near but offered no possibility of ascent. In the immediate vicinity were two snow-covered skerries, and in the distance were exposed rocks towards which Lützow-Holm and Riiser-Larsen set out on skis to gather specimens. After having marched more than two hours the prospect of bad weather decided the two men to return before they had reached their objective. On their return to the skerries ($66^{\circ} 33' \text{ S.}$ and $50^{\circ} 40' \text{ E.}$) they there raised the Norwegian flag presented to them by the King and Queen of Norway. This would seem to be a point on the Enderby Land coast a few miles southwest of Biscoe's Cape Ann, although Biscoe's position for that cape (see below, p. 32) does not quite fit into the alignment of the coast as now doubtless more correctly laid down by Riiser-Larsen. The planes returned safely to the ship in spite of foggy and windy weather.

The *Norvegia* now proceeded a considerable distance westward (to about 64° S. and 22° E.) to meet the *Thorshammer* to recoal. Then, returning to the attack, she was able to advance southward

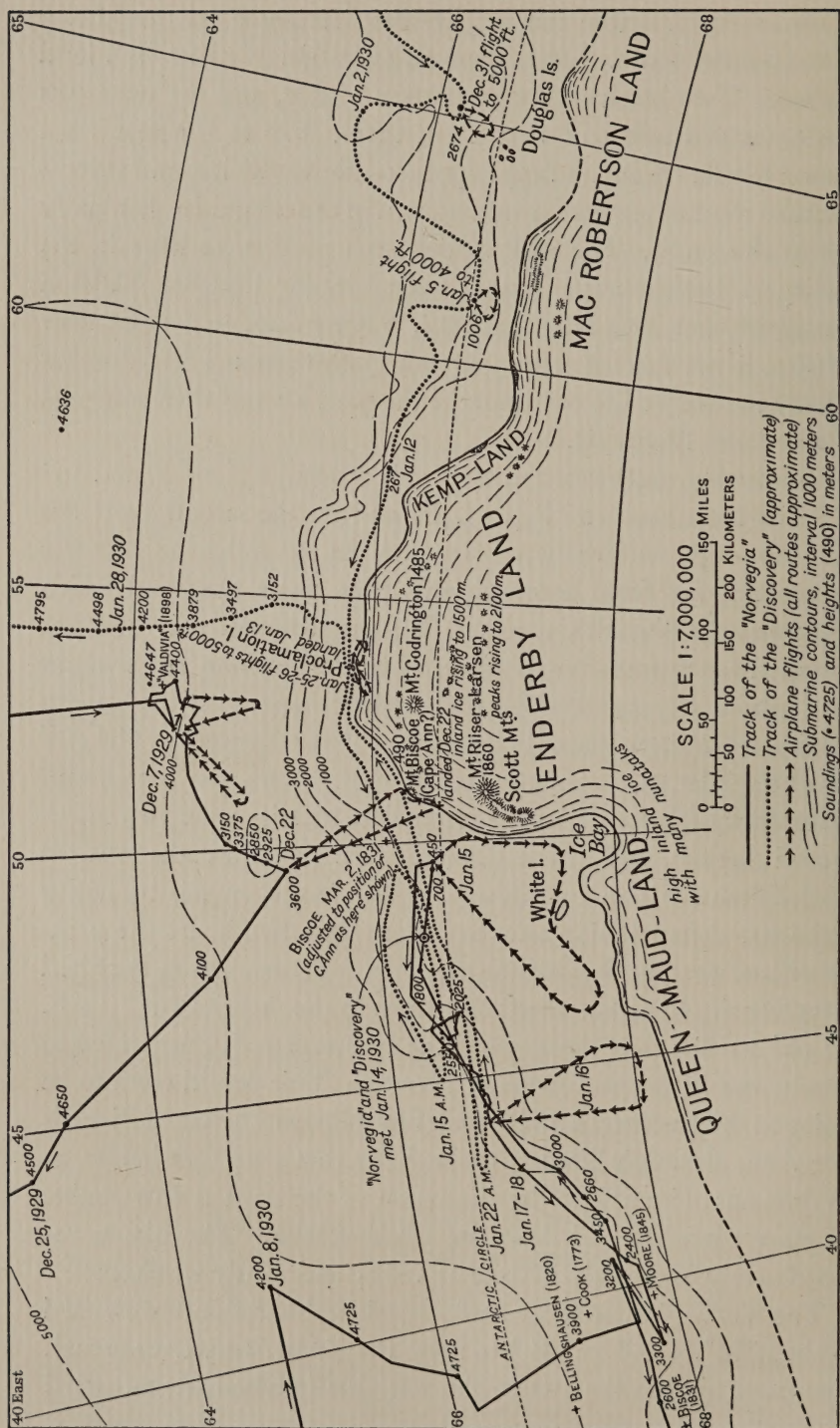


Fig. 2.—Map of Enderby Land and the newly discovered lands in its vicinity as mapped in 1929-1930 by Mawson and Riiser-Larsen, together with the tracks of the *Discovery* and the *Norvegia*. (From original manuscript maps furnished the American Geographical Society by both leaders.) Scale 1:7,000,000.

again about in longitude 40° E. between January 8 and 13. Here in open water she advanced eastwards, reaching a point in $66^{\circ} 28'$ S. and $49^{\circ} 30'$ E., or about 40 miles west of Cape Ann, on January 15. It was on this eastward leg that the *Discovery* was met on January 14 and a visit exchanged with Sir Douglas Mawson (see below, p. 33). From the point reached a long flight was made, first to the southward, which disclosed the southern trend of the west coast of Enderby Land to a large bay heading in 68° S. and 50° E., which was named Ice Bay, and then to the westward, which revealed the coast as trending in general west-southwest from Ice Bay. After the plane returned to the ship the *Norvegia* proceeded to a point in about $66^{\circ} 40'$ S. and 44° E. from which another flight was made on January 16 southward to the newly discovered land, and this was mapped westward to 43° E. from the point where work had been suspended before. The land between Ice Bay and 43° E. was named Queen Maud Land. It is high land covered by inland ice from which project many nunataks, indeed so many that it was out of the question for Riiser-Larsen to map them.

Skirting Antarctica in the African Quadrant

The *Norvegia* now hurried westward to fulfill her program, which called for oceanographical stations along the edge of the ice as far as Coats Land (Fig. 1). On February 1 in latitude 68° S., between longitudes $32^{\circ} 11'$ and $32^{\circ} 38'$ E., soundings indicated an extensive shoal of 580 to 660 meters. This was named Gunnerus Bank after Johan Ernst Gunnerus, Bishop of Trondjem and naturalist, who in 1770 was the first to describe the pelagic shrimp. There was an appearance of land about 80 miles south-southeast of the bank, which makes it possible that the bank represents a projection of the continental shelf rather than an isolated shoal.

Proceeding now rapidly westward the *Norvegia* on February 16 rounded the northwestern corner of the pack ice in about $68\frac{1}{2}^{\circ}$ S. and $113\frac{1}{4}^{\circ}$ W. and headed into Weddell Sea. An echo sounding of 4935 meters at this point corresponds very well with the *Scotia's* sounding in 1904 of 4865 meters about 25 miles farther west.^{20a}

^{20a} *Scottish Geogr. Mag.*, Vol. 21, 1905, pp. 405-407.

Discovery of Crown Princess Martha Land

On turning southwards the depths gradually decreased until they shoaled to 200 and 300 meters in about $71\frac{1}{3}^{\circ}$ S. and 13° W., where a long row of icebergs trending east by north to west by south was aground. Passing through this row the ship advanced to a point in about $71^{\circ} 26'$ S. and $12^{\circ} 8'$ W. to within 500 feet of what the dawn of February 18 disclosed as a wall of inland ice. From this point a flight was made in spite of threatening weather conditions. The inland ice face was followed southward to about $71\frac{2}{3}^{\circ}$ and then southwestward until fog closed about the plane and forced it to return to the vicinity of the ship. Here conditions were slightly better, and the inland ice was traced northward to about $71\frac{1}{5}^{\circ}$, where it turned eastwards. Along this eastward stretch level ice was encountered, apparently floating shelf ice, but the poor visibility did not make it possible to determine where the inland ice ended and the shelf ice began.

After the plane had returned to the ship the *Norvegia* advanced farther into the bay outlined on the first leg of the flight. This bay, because of the abundance of seals, was named Seal Bay. The cape where the land turned from a north-south direction in $71\frac{1}{5}^{\circ}$ to an easterly direction was named Cape Norvegia.

Retracing her course through the belt of grounded icebergs the *Norvegia* now proceeded westward to $71^{\circ} 26'$ S. and $14^{\circ} 58'$ W., where on February 20 she was stopped by pack ice, which here had a northerly trend. From this point another flight was made toward the southeast, finally reaching an elevation of 5000 feet. As the clouds had disappeared southward it was now possible to see the coast line continuously from Coats Land, discovered by Bruce in 1904, to the land discovered on the February 18 flight. This stretch of coast, between Seal Bay and Coats Land, trended northeast-southwest. The land disclosed on the flights of February 18 and February 20 was named Crown Princess Martha Land. This low land covered by inland ice uninterrupted by nunataks resembles the land (Luitpold Land, Caird Land, Coats Land) forming the eastern shore of Weddell Sea, of which land it is the northeastern continuation.

Gales now held the *Norvegia* until February 23, when she was able to round Cape Norvegia and on a northeastern course map the coast from the ship somewhat farther than it had been possible to do from the plane in the thick weather of February 18.

Return of Expedition and Plans for 1930-1931

Passing out of sight of land the ship continued northward along the western edge of the pack ice, which the recent gales had pushed farther west. Finally in about $69\frac{1}{2}^{\circ}$ S. and 14° W. the corner of the ice was reached and the course set eastward to get farther south than Bellingshausen in 1820 ($68^{\circ} 37'$ S. and $1^{\circ} 44'$ W.) and Biscoe in 1831 ($69^{\circ} 3'$ S. and $10^{\circ} 43'$ W.), but this proved to be impossible. As the coal supply was diminishing the expedition made for an agreed rendezvous with the *Thorshammer*, which was reached on March 2 in about 67° S. and 12° E. The airplanes and equipment were transferred again to the *Thorshammer*, and, after bunkering, the *Norvegia* sailed directly for Cape Town, where she arrived safely on March 22, 1930.

For the season of 1930-1931 a program has been laid out for the *Norvegia* involving the circumnavigation of almost the entire Antarctic, which, by binding together and rounding out her three previous cruises, will, it is hoped, represent a certain completion of her work. The *Norvegia* has been repaired and fully equipped in Cape Town since March and is to start south from there immediately on the arrival of her crew, which left Norway on August 5 on the *Thorshammer*. The *Thorshammer* will again provide her with coal at several points on her route. The *Norvegia* will first proceed southward to sound for possible shoals or islands on the eastern end of the submarine ridge from which Bouvet Island rises. Then, approaching the continent near Enderby Land, she expects to continue eastwards in Antarctic waters, in general following the pack-ice edge, all the way to Ross Sea. From here she will make another attempt to find Dougherty Island (see above, p. 21) by proceeding to the position assigned by the Norwegian polar patron, H. J. Bull, viz. $59^{\circ} 48'$ S. and $118^{\circ} 40'$ W. Turning thence southward the *Norvegia* will again skirt the pack-ice eastward to

Peter I Island, where a hut for shipwrecked mariners will be erected. From here she will return to Norway by way of the South Shetlands and Montevideo. Owing to the fact that naval duties will make it impossible for Commander Riiser-Larsen again to be the leader, Major Gunnar Isachsen, well known for his exploratory work in Spitsbergen and the Canadian Arctic Archipelago and latterly a participant in Antarctic whaling cruises, will be in command.^{20b}

MAWSON ANTARCTIC EXPEDITION OF 1929-1930²¹

The second of the two major expeditions that worked on the opposite side of the Antarctic to Byrd and Wilkins (that of Riiser-Larsen being the other) was the British, Australian, and New Zealand Antarctic Research Expedition under Sir Douglas Mawson, sponsored by the three governments named in its title. The main objective of this expedition was that part of the Antarctic Continent south of Australia in which the Commonwealth has a special interest, conceived as "extending from the Ross Sea in the east to Enderby Land in the west."²² The segment immediately facing Australia had been the scene of the Australasian Antarctic Expedition of 1911-1914 under the same leader. In the inner portion of this segment, between longitudes 100° and 130° E., it had not been possible at that time to reach and outline the coast; hence that area was envisaged for special examination on the present expedition. An important adjunct of the expedition was a small scouting airplane which, although not suited to long flights, was invaluable in increasing the range of vision and in observing the position of the pack ice as an aid to navigation. The personnel numbered forty, includ-

^{20b} Communication from Mr. Bjarne Aagaard.

²¹ Based on three parallel accounts by Sir Douglas Mawson: (1) The Antarctic Cruise of the "Discovery," 1929-1930, *Geogr. Rev.*, Vol. 20, 1930, pp. 535-554, with map in two parts, a track chart in 1:25,000,000 and a map of the newly discovered lands in 1:6,000,000; (2) British, Australian, and New Zealand Antarctic Research Expedition: Report on the Work of the Expedition in R. S. S. "Discovery" during the Season 1929-1930 (8 pp., mimeographed), submitted to the Commonwealth of Australia House of Representatives on May 21, 1930; (3) two summarizing articles in the *New York American*, July 20 and 27, 1930; all three accounts supplemented for details by the wireless despatches from the expedition while in the field as published with slight variations from each other in the *London Times Weekly Edition*, Oct. 31, 1929-March 27, 1930, and the *New York American* every few days from Oct. 29, 1929, to March 30, 1930.

²² Australian Expedition to the Antarctic: Statement by the Prime Minister, the Right Hon. S. M. Bruce (made in the House of Representatives 21st February, 1929), Parliament of the Commonwealth of Australia, Canberra, 1929.

ing twelve men on the scientific and technical staff besides the leader. Scott's old vessel, the *Discovery*, was placed at the disposal of the expedition by the British Government. Captain J. K. Davis, who acted in a like capacity on the *Aurora* on the expedition of 1911-1914, was navigating captain of the *Discovery* and second in command.

*Oceanographical Work: Sounding the Kerguelen-Gaussberg
Submarine Ridge*

The *Discovery* sailed from Cape Town on October 19, 1929, stopped at Possession Island of the Crozet group on November 2-4, and, after having been driven off for three days by a severe storm, reached Kerguelen on November 12 (Fig. 1), where anchor was dropped in Port Jeanne d'Arc, Royal Sound, southeastern part of the island. Twelve days were occupied in coaling and in field work, including a visit to H. E. Bossière fiord. Leaving Kerguelen on November 24 the *Discovery* arrived at Heard Island²³ on November 26. A party that was landed for surveying and other scientific work was marooned ashore for five days owing to stormy weather. The *Discovery* was finally able to leave on December 3. A course was set southeast to about 55° S. and then south about along the meridian of 78° E. Along this course the submarine ridge, termed Kerguelen-Gaussberg Ridge on the accompanying bathymetric map of the Antarctic, which separates the Indian Antarctic Basin, with its colder bottom water on the east, from the Atlantic-Indian Antarctic Basin on the west, was found to be even more pronounced a feature than conjectured from the results of the *Challenger* and *Gauss* expeditions. A continuous series of decreasing depths as revealed by echo soundings culminated in a sounding of only 640 meters in 59° 10' S. and 77° 45' E. Thereafter the depths increased, but Mawson believes that the ridge continues on the eastern side of the here southward track of the *Discovery*.

²³ At this point mention may be made, as coming within the scope of the present history, of the exploration, for the Société des Pêches Australes, of Kerguelen and Heard Island by the French geologist E. Aubert de La Rüe in January, 1929 (Un voyage d'exploration dans les mers australes, *Rev. de Géogr. Physique et de Géol. Dynamique*, Paris, Vol. 2, 1929, pp. 97-146; Voyage d'exploration à l'île Heard, *Renseign. Colon. (Suppl. à L'Afrique Française*, June, 1930), pp. 342-355.

The first icebergs were met in about 59° S. By the time latitude $61\frac{1}{2}^{\circ}$ S. was reached the sea was studded with icebergs and fragments of old sea ice. This condition increased steadily, until on December 13 in $65^{\circ} 5' \text{ S.}$ and $81^{\circ} 1' \text{ E.}$, at the southeastern apex of her route, the *Discovery* was held fast in the pack ice. Two days later she was able to free herself, and thence her course for the strictly Antarctic part of the voyage was westward, with recurring outward bends to the north to avoid the solid pack.

Discovery of MacRobertson Land and Mapping of Kemp and Enderby Lands

On December 16 the ship was in $65^{\circ} 41' \text{ S.}$ and about $79\frac{1}{2}^{\circ} \text{ E.}$ and hence, to judge by the position of the land to the southeast determined by the *Gauss* expedition in 1901-1903 and of land discovered somewhat later to the southwest on the present expedition, was probably not more than 130 miles from the coast. It was not until December 26, however, that a sounding of 472 meters in $66^{\circ} 57' \text{ S.}$ and $71^{\circ} 57' \text{ E.}$, following on a depth of 1185 meters at a point farther out (about 45 miles to the northeast), indicated the close proximity of land. Dredgings of large quantities of granite and gneiss erratics similar to those of the known lands to the east implied land of continental type. Its distance was estimated at about 50 miles. Unfortunately the scouting plane could not be used on these two occasions, as on the earlier it was not ready and on the second the weather was unfavorable.

Finally, on December 31, the ship's position being $66^{\circ} 10' \text{ S.}$ and $65^{\circ} 10' \text{ E.}$ (Fig. 2) and the day being clear, an ascent to 5000 feet was made by Flight Lieutenant S. Campbell and Air Pilot E. Douglas. From this elevation could be seen toward the south, first, a belt 40-45 miles wide of practically unbroken pack ice, then a belt of open water about 10 miles wide, and beyond it the undulating slopes of ice-covered land. To the southwest arose out of the pack-ice belt the black tips of what were apparently several small islands, which were named the Douglas Islands. These islands create a northward projection of the belt by holding up the pack ice in its westward drift with the coastal current. On continuing westward, a favorable opportunity for a flight occurred again on

January 5, 1930. From a position about on the Antarctic Circle and the 61st meridian Sir Douglas Mawson with Campbell as pilot ascended to 4000 feet and flew a few miles east and west and towards the land, which presented a magnificent spectacle from the air. To the east, west, and south high ice-covered land extended to the horizon. Occasional peaks broke through the inland-ice surface, which rose steadily to the southward. The coast line was not more than 30 miles from the ship. Southeast of the ship's position and immediately back of the coast lay a dark rocky mountain mass trending east-west and reaching heights of several thousand feet. The land discovered on this day together with that sighted on December 31 was named MacRobertson Land, the name by which Mr. Macpherson Robertson of Melbourne, who made a large financial contribution to the expedition, is best known in Australia. Its coast lies in general along the 67th parallel, and the land may be considered to extend between the 60th and 67th meridians.

After being delayed by a hurricane on January 6 and its aftermath the *Discovery* continued westward on January 11. This brought her along the coast of Kemp Land, sighted by the British sealer Kemp in December, 1833. Possibly drawing on unpublished information Mawson says²⁴ that Kemp had only two chronometers and that they did not agree. According to one the longitude of Kemp's landfall would be 59° E., according to the other $56\frac{1}{2}^{\circ}$ E. The coast, as observed on the present expedition, runs in a north-westerly direction from 67° S. and 59° E. to $66\frac{1}{5}^{\circ}$ S. and 57° E. In longitude $56\frac{1}{2}^{\circ}$ land does lie in the latitude that Mawson states Kemp indicated as that of his landfall whereas in 59° E. it lies 55 miles farther south. Kemp Land is usually represented on maps as centering on the 59th meridian, but Mawson therefore believes it should appear about $2\frac{1}{2}$ degrees farther west.

Continuing westward the *Discovery* on January 13 arrived at a striking feature of the coast, a pyramid-shaped rocky island 800 feet high in about $65^{\circ} 51'$ S. and $53\frac{1}{2}^{\circ}$ E., separated from the mainland by a channel several hundred yards wide. Viewed in

²⁴ Wireless despatch from the expedition in the field, dated January 14 or 15, 1930, printed in the *New York American*, Jan. 25, 1930, and the *London Times Weekly Edition*, Jan. 30, 1930. Mill in his "Siege of the South Pole," London, 1905 (p. 167), states that the track chart is the only source of information available of this voyage.

the light of the completed explorations in this area the island constitutes the apex of the 250-mile wide land mass that projects out from the main body of the Antarctic Continent between longitudes 50° and 59° E. and whose northwestern side it was that Biscoe had discovered in February, 1831, and named, after his merchant employers, Enderby Land. A party of the Mawson expedition ascended to the top of the island and raised the Union Jack to reaffirm British interest in this territory. The island was named Proclamation Island, and a cairn and record were left on its summit.

Rounding in about $52\frac{1}{2}^{\circ}$ E. the northwestern corner of the projecting land mass, the *Discovery* now followed the pack-ice edge in a west-southwest direction. As the coast trended southwest the distance of the vessel from the shore grew increasingly and the view of the land became limited to the higher portions only. Among these were a peak (originally seen from the top of Proclamation Island) 4870 feet high, in about $66^{\circ} 20'$ S. and $52\frac{3}{4}^{\circ}$ E., identified as Biscoe's Mount Codrington, and a range extending back from the coast along the 67th parallel, which was named Scott Mountains, culminating in about 51° E. in a 6100-foot peak which was named Mount Riiser-Larsen. A black rocky mountain rising steeply from the sea front to a height of 1600 feet was named Mount Biscoe. The photograph of the headland that Riiser-Larsen took to be Biscoe's Cape Ann (see above, p. 23) and Mawson's photograph of Mount Biscoe²⁵ show the two to be the same feature. Mawson's revised position of about $66^{\circ} 25'$ S. and $50^{\circ} 18'$ E. for Mount Biscoe fits in well with the probable course of Riiser-Larsen's December 22 flight and almost coincides with the position of Cape Ann as shown on the British Admiralty chart.²⁶ When these circumstances are taken into consideration, together with the fact that the attention of all three explorers is likely to have been attracted by the most prominent feature, the conclusion seems rea-

²⁵ *Geogr. Rev.*, Vol. 20, 1930, p. 549 (Mawson) and p. 563 (Riiser-Larsen).

²⁶ No. 3170 (Antarctic Ocean, Sheet I), editions of July 31, 1914, and June 3, 1927. On the two editions of the chart the cape is shown in about $66^{\circ} 25'$ S. and $50^{\circ} 15'$ E. This is nearly a degree farther east than the position assigned by Biscoe himself, $66^{\circ} 25'$ S. and $49^{\circ} 18'$ E. (Extracts from the "Journal of a voyage towards the South Pole aboard the Brig 'Tula,' under the command of John Biscoe, etc.," in "The Antarctic Manual for the Use of the Expedition of 1901," edited by George Murray, Royal Geogr. Soc., London, 1901, pp. 305-335; reference on p. 323). This parallel transposition eastward on Chart 3170 of Cape Ann (and likewise of Biscoe's route in this vicinity) seems, in view of the now known position of the Enderby Land coast, better to conform with the facts.

sonable that Riiser-Larsen's assumed Cape Ann and Mawson's Mount Biscoe are Biscoe's Cape Ann.

While the *Discovery* was proceeding on this west-southwest course in about longitude 47° E. (and about $66\frac{1}{3}^{\circ}$ S.), on the evening of January 14 the *Norvegia* hove in sight going eastwards. She was on her second visit to the area in three weeks (see above, p. 25). Commander Riiser-Larsen came on board the *Discovery*, and he and Sir Douglas discussed their respective programs. Mawson stated that the extreme western limit of his sphere of operations was the 40th meridian. After the vessels parted the *Discovery* continued west as far as 45° E., where she turned back east to resume a closer examination of Enderby Land. On January 16 the *Norvegia* passed her going back west. Before she reached the coast, however, a violent gale overtook the *Discovery* on the evening of the same day, when in $66^{\circ} 11'$ S. and $49^{\circ} 33'$ E. Against it she was able to hold out in that position for two days but was then driven 150 miles west-southwest, or about to the 43rd meridian—beyond her farthest west of a few days before. With the return of better weather on January 22 she retraced her course eastward, passing on January 23 in $66^{\circ} 22'$ S. and $48^{\circ} 30'$ E. what appeared to be the tip of a shelf-ice tongue and reaching Proclamation Island again on January 24. From here and from a point a little farther east several short scouting flights were made during the next two days to an elevation of 5000 feet, which revealed much of the interior of the projecting land mass. Numerous bare rock peaks, often in rectilinear arrangement, protruded above the inland-ice surface, which rose steadily to the south, attaining an elevation of about 5000 feet, with peaks projecting in this highest portion to an estimated height of 7000 feet.

Return of Expedition and Plans for 1930-1931

The coal supply now having reached the minimum necessary for safe return, the *Discovery* was reluctantly headed north on January 26 (Fig. 1), although another month of open season might be expected. Soundings shortly after leaving Proclamation Island showed that the continental shelf here is narrow, the bottom sloping to 1000 meters in 20 miles and to 3000 meters in 35 miles. A

northeast gale from January 30 to February 1 in 63° S. further depleted the coal supply. Kerguelen was reached on February 8, and the vessel again anchored in Royal Sound. The twelve days occupied in coaling were utilized for survey work, by airplane and motor launch. Nearly on the site of the magnetic observatory of the *Gauss* expedition the magnetic elements were redetermined for comparison with the values of twenty-nine years ago. Winter weather finally set in, making it impossible for the *Discovery* to leave before March 2 and frustrating the plan of revisiting Heard Island, and even more effectively that of going by way of Queen Mary Land on the Antarctic coast (100° E.) en route to Australia. A direct course was therefore shaped for the southwestern corner of Australia, soundings being made and hydrographic data collected for the whole distance. Albany was passed on March 21, and the expedition terminated by reaching Adelaide on April 1.

Although in the original plans it was hoped that the expedition could continue for a second field season there were not sufficient funds available to assure this at the time. These have now been forthcoming, and Sir Douglas expects to leave Hobart, Tasmania, early in November, 1930, with the intention of outlining as much as possible of the unknown coast between the easternmost landfall of the present expedition and 160° E.²⁷ These unsurveyed gaps lie roughly between the following meridians: 67° - 85° E., 102° - 130° E., 153° - 157° E.

Arctic Exploration

In taking up now the story of the present period of exploration in the Arctic, that is to say the period since the introduction of the airplane and the airship in the unveiling of the North, we may be briefer in dealing with individual expeditions, as their results are necessarily less comprehensive than those of the recent expeditions in the Antarctic.

PRECURSORS OF THE PRESENT PERIOD

If in the Antarctic there have been earlier attempts to apply aviation to exploration, this holds true to a much greater degree in the Arctic, because of closer proximity to the centers of population and because of less severe meteorological conditions.

²⁷ *New York Times*, May 5, 1930.

The record begins with the ill-fated journey of the Swedish aeronaut Andrée in a drift balloon from Spitsbergen in 1897. The finding, by Dr. Gunnar Horn and his party, of Andrée's remains, together with those of his two companions, on White Island (about 80° N. and 32° E.) in August, 1930, to which the three had sledged southward over the pack ice from 83° N. and 30° E., the probable location of the descent of the balloon, is one of the dramatic events of polar history.

In 1906 Walter Wellman, a journalist, built a dirigible airship for a voyage to the North Pole and established headquarters in Spitsbergen. An unsuccessful attempt to fly the airship in 1907 was followed by partial success in 1909, when Wellman succeeded in reaching a point over the pack ice 60 miles north of Spitsbergen. In 1910 an official German commission made a trip to Spitsbergen to see whether it would be feasible to establish a base there for a Zeppelin airship to be used in the exploration of the Arctic.²⁸ Although the findings of the commission were favorable no practical results followed.

The year 1914 brought the first actual airplane flights in the Arctic. In connection with the expedition organized to rescue the Sedov party, the Russian Lieutenant Nagurski was sent to Cross Bay, Novaya Zemlya, with a Farman hydroplane. From that point he made a number of flights northward along the west coast of that island—the farthest, to the Barents Islands (76° 20' N.), 200 miles distant—and one flight 70 miles out over the pack ice of Barents Sea to a point in 76° 24' N. and 55° 26' E.²⁹

The next two occurrences are related immediately to the subsequent flights by Amundsen and Ellsworth which ushered in the new era of successful aerial exploration in the Arctic. In 1922 Amundsen purchased a Junkers monoplane, which was shipped to Seattle, and there loaded it on his vessel the *Maud*, which, after her three-year completion of the Northeast Passage (1918-1921), was then about to proceed to Wrangel Island, there to enter the pack ice for the drift across the Arctic Sea. In addition there was loaded

²⁸ A. Miehe and H. Hergesell, eds.: *Mit Zeppelin nach Spitzbergen: Bilder von der Studienreise der deutschen arktischen Zeppelin-Expedition*, Berlin, 1911.

²⁹ M. Zhdanko: *Pervyi gidroaeroplan v Syevernom Ledovitom Okeanye* (The first hydroplane in the Arctic Ocean), *Zapiski po Gidrogr.*, Vol. 38, No. 5, Petrograd, 1915, pp. 674-685, with map of flights in 1:1,000,000.

on the *Maud* a small Curtiss reconnoitering plane which the Curtiss company had put at Amundsen's disposal. The Curtiss machine was subsequently flown twice, on relatively short flights, but it crashed in the second landing. The Junkers plane was unloaded again at Point Hope, Alaska, and taken thence by Amundsen to Wainwright. From there he planned to fly into the unknown area north of Alaska and via the Pole to Spitsbergen. After wintering there with his pilot, Lieutenant Omdal, Amundsen was ready in May, 1923; but on the first trial flight the plane was hopelessly damaged.³⁰ In connection with the preparations to assist Amundsen on his expected arrival on the opposite side of the Arctic Basin a number of flights were made over different parts of Spitsbergen by Lieutenant Mittelholzer of the Swiss Army.³¹

In 1924 the third Oxford University Arctic Expedition, under the leadership of George Binney, went to Spitsbergen with a seaplane specially equipped for photographic mapping.³² Among other areas parts of Northeast Land were photographed.

AMUNDSEN-ELLSWORTH POLAR FLIGHT OF 1925³³

In 1925, mainly through the generosity of Mr. Lincoln Ellsworth and his father, Amundsen was in a position to realize his plans. Two Dornier-Wal seaplanes were purchased. On May 21, 1925, departure was made from Kings Bay, Spitsbergen, for a flight to the North Pole, with three men in each plane, Amundsen commanding one, Ellsworth the other. Captain Riiser-Larsen of the Norwegian Navy was one of the navigators. After flying eight hours half the gasoline had been used, and a landing had to be made in a large lead near by (for route, see the map of the Arctic). The position was $87^{\circ} 43' \text{ N.}$ and approximately $10^{\circ} 21' \text{ W.}$ One plane was abandoned, but to take off again it was necessary to prepare a runway on the ice. This heart-breaking job was finally accomplished only after enormous effort and after five unsuccessful

³⁰ Roald Amundsen and Lincoln Ellsworth: *Our Polar Flight*, New York, 1925, pp. 7-8; H. U. Sverdrup: *Magnetic, Atmospheric-Electric, and Auroral Results, Maud Expedition, 1918-1925, Part 6: Narrative of the Expedition, 1918-1925, Researches Dept. Terrestr. Magnet.*, Vol. 6, pp. 519-520, Carnegie Institution, Washington, 1927.

³¹ Walter Mittelholzer: *Im Flugzeug dem Nordpol entgegen*, Zurich, 1924, with excellent air photographs.

³² George Binney: *With Seaplane and Sledge in the Arctic*, London, n.d.

³³ Roald Amundsen and Lincoln Ellsworth: *Our Polar Flight*, New York, 1925.

attempts to take off. On the sixth attempt, each one endangering lives as well as the remaining plane, the machine rose with all six men and returned safely to Spitsbergen in eight hours on June 15.

On the northward course 100,000 square kilometers were observed without sign of land, and at the point of descent two echo soundings were made which showed a depth of 3750 meters. This goes to confirm Nansen's view of a deep polar basin.

BYRD'S FLIGHTS OVER ELLESMERE ISLAND, 1925³⁴

In the same summer Byrd, as commanding officer of the U. S. Naval Aviation Arctic Unit, was attached to the MacMillan expedition. He made numerous flights in a Loening amphibian from Etah, on the Greenland side of Smith Sound, most of them westward toward Cape Sabine and Bache Peninsula. One extended as far as Eureka Sound, and another long flight east led from Robertson Bay in a triangular course for 150 miles over the Greenland ice cap north of Inglefield Gulf. This was the first extensive flight ever made over an ice cap.

BYRD'S FLIGHT TO THE NORTH POLE, 1926³⁵

On May 9, 1926, flying from Kings Bay, Spitsbergen, Byrd, with Floyd Bennett as pilot, covered the 850 miles to the North Pole in about eight hours (for route, see map of the Arctic). The fact that on the return journey Byrd struck his starting point exactly speaks eloquently for the accuracy of his navigation. Without that exactitude, without the good fortune of continuous sunshine, Byrd and Bennett might never have been seen again. By this exploit Byrd and Bennett, who has since died, were the first to attain one of the poles by airplane.

AMUNDSEN-ELLSWORTH TRANSPOLAR FLIGHT ON THE "NORGE," 1926³⁶

The *Norge* flight cut completely across an hitherto unknown area in the Arctic Sea, and, although visibility was poor in some

³⁴ R. E. Byrd: Flying over the Arctic, *Natl. Geogr. Mag.*, Vol. 48, 1925, pp. 519-532. The individual flights are indicated on the inset "Ellesmere Island Region" of the National Geographic Society's map of the Arctic Region, 1:14,673,400, Washington, 1925.

³⁵ R. E. Byrd: *Skyward*, New York, 1928, Chapters 9 and 10.

³⁶ Roald Amundsen and Lincoln Ellsworth: *First Crossing of the Polar Sea*, New York, 1927.

places along the route, as suggested on the present map of the Arctic, it added confirmation to the theory of a deep polar sea.

The airship *Norge*, built in Italy, went on her own power from Rome by a circuitous route to Vadsö in northern Norway and thence to Spitsbergen. Her designer, General Umberto Nobile, was the pilot on the expedition. Amundsen and Ellsworth were the leaders. Riiser-Larsen was the navigator. Starting from Kings Bay on May 11, 1926, the *Norge* reached the Pole on May 12, in $4\frac{1}{2}$ hours (for route, see the map of the Arctic). Thence the airship followed approximately the 156th meridian and reached the Alaskan coast in about seven hours more. It was only then that she entered the belt of storms, a circumstance which forced her to land where best she could, viz. at Teller instead of at Nome, as intended.

WILKINS' 1926 AND 1927 ARCTIC FLIGHTS³⁷

The object of these flights was to explore the unknown area immediately to the north of Alaska. The logical base was Point Barrow, but supplies had first to be collected there. To do this the airplane was used, with very satisfactory results, but, necessarily, it meant curtailing other flights. Most of the flying in 1926, there-

fore, was done between Fairbanks and Point Barrow only; but, as this was across an unknown section of the Brooks Range, new territory was disclosed.

In 1927 the work was more advanced. In view of the swath through the unknown area that had been cut by the path of the *Norge*, Wilkins decided to penetrate the unknown between the track of the *Norge* and the track of the *Jeannette* (see

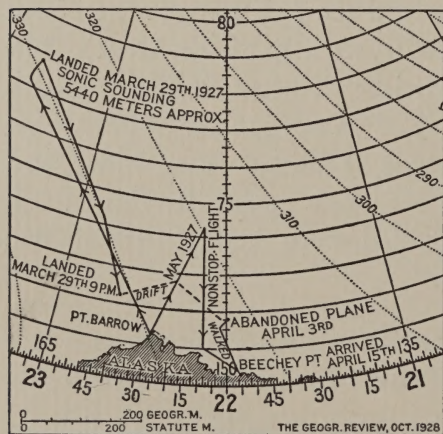


Fig. 3—Wilkins' flights of 1927 northwest and north of Point Barrow, Alaska. Scale 1:20,000,000

Fig. 3 and the map of the Arctic). On March 29, 1927, Wilkins,

³⁷ *Geogr. Rev.*, Vol. 18, 1928, pp. 489-492 and 527-538.

with Eielson as pilot, flew northwest from Point Barrow a distance of about 500 miles in less than $5\frac{1}{2}$ hours and landed on the pack ice at a point estimated to lie in $77^{\circ} 45' \text{ N.}$ and 175° W. With an echo sounder he made a sounding which there is every reason to

NAVIGATIONAL CHART
OF THE
ARCTIC BASIN

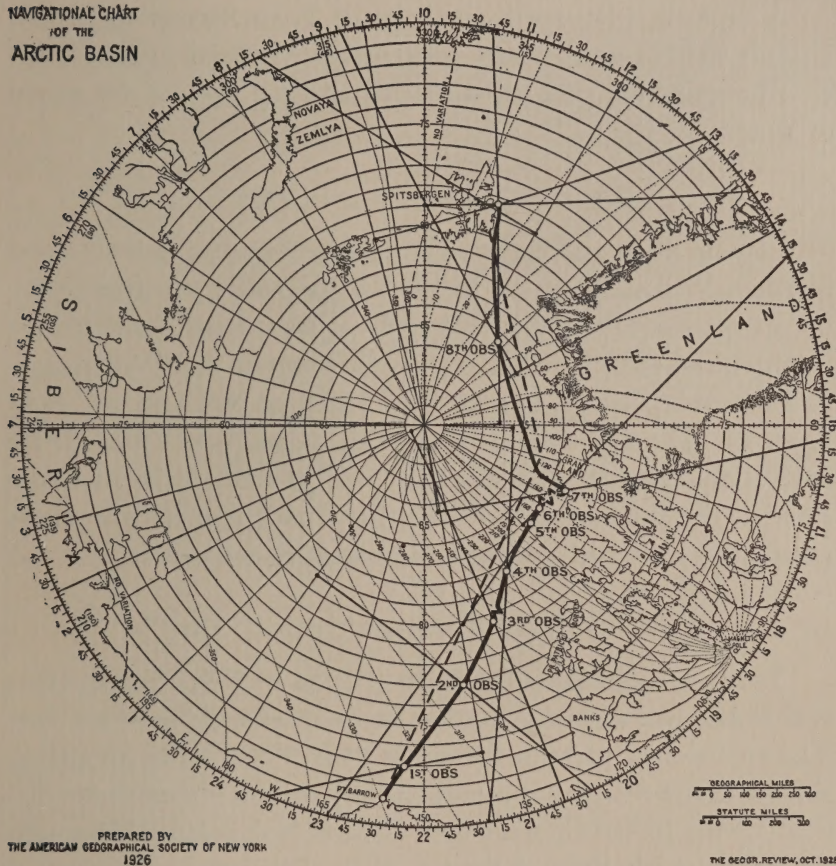


FIG. 4.—The route of Wilkins' Alaska-Spitsbergen flight (bold continuous line) together with auxiliary lines used in plotting the course from the astronomical observations. Scale 1:40,000,000.

consider correct, as several records were made at the same place and all checked. This depth is 5440 meters—the greatest so far recorded in the Arctic Sea. On its return the airplane had to fight headwinds through a heavy storm that had developed, and Wilkins and Eielson were thus forced to land on the pack ice about 100 miles northwest of Point Barrow (see Fig. 3). From here

the current drifted them eastwards about 200 miles in six days. At this point they abandoned the plane and walked the 80 miles to the Alaskan shore at Beechey Point, building snowhouses on the way and having to crawl on hands and knees over the rafted belts of pack ice near shore.

A flight in May north-northeast of Point Barrow to beyond latitude 74° N., with a return south to Beechey Point (Fig. 3), disclosed nothing but pack ice and terminated the work of the season of 1927.

WILKINS' ALASKA-SPITSBERGEN FLIGHT OF 1928³⁸

Having made a sortie into the area northwest of Point Barrow in 1927, Wilkins proposed in 1928 to penetrate the area to the northeast—not to stop there but to fly across to Spitsbergen via the northern end of Greenland. This is the program that Wilkins carried out so brilliantly, in a 20-hour flight, on April 15-16, 1928 (Fig. 4). The flight stands unparalleled as a piece of Arctic air navigation. That Wilkins correctly “hit” the mountains of Grant Land at the end of the 1200-mile leg from Point Barrow shows exceptional ability in holding to a predetermined course.

NOBILE'S FLIGHTS ON THE “ITALIA,” 1928³⁹

Ever since the transpolar flight of 1926 with Amundsen, General Nobile had wished to conduct an Arctic expedition of his own. The opportunity presented itself in 1928. The *Italia*, an airship similar to the *Norge* but somewhat larger, was placed at his disposal by the Italian Government. General Nobile himself brought the airship safely through from Rome to Spitsbergen. Altogether two main flights were made, one eastward to Northern Land, the other northward to the Pole (see Fig. 5 and the accompanying Arctic map).

³⁸ Sir Hubert Wilkins: The Flight from Alaska to Spitsbergen, 1928, and the Preliminary Flights of 1926 and 1927, *Geogr. Rev.*, Vol. 18, 1928, pp. 527-555; *idem*: Flying the Arctic, New York, 1928, Chapters 6-11.

³⁹ Umberto Nobile: With the “Italia” to the North Pole, London, 1930. See also *Geogr. Rev.*, Vol. 19, 1929, pp. 683-685, where a number of books discussing the rescue are enumerated. The scientific results of the *Italia* flights have been published in German: Umberto Nobile: Die Vorbereitungen und die wissenschaftlichen Ergebnisse der Polarexpedition der “Italia,” with contributions by F. Behounek, F. Malmgren, A. Pontremoli, etc., *Ergänzungsheft No. 205 zu Petermanns Mitt.*, Gotha, 1929.

The voyage to Northern Land began on May 15, 1928, and led eastward north of Franz Josef Land, demonstrating the non-existence of Gillis Land (reported in 1707) at its charted position of $81^{\circ} 40' \text{ N.}$ and $37^{\circ} 5' \text{ E.}$ Continuing eastward Nobile was unable, on account of weather conditions, to go farther than $79^{\circ} 16' \text{ N.}$ and

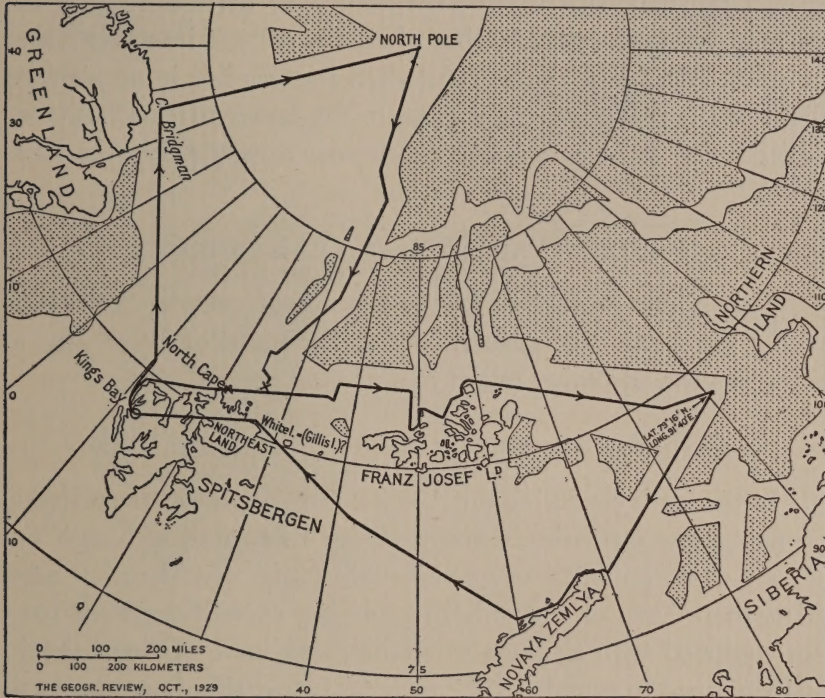


FIG. 5—Map showing routes of the *Italia* on the Northern Land and North Pole flights, May, 1928. Scale 1:20,000,000.

Areas unexplored or not seen are shown in stipple. The routes of the *Italia* and the estimated areas seen along her path are based on manuscript maps sent to the American Geographical Society by General Nobile.

$91^{\circ} 40' \text{ E.}$, which point just falls short of Northern Land, the nature of whose western coast it was the prime object of the expedition to determine. From there a storm swept him southwest to the northern tip of Novaya Zemlya, whence he finally regained Spitsbergen.

The flight to the Pole took place on May 23 by way of Cape Bridgman in northernmost Greenland. This westerly leg opened up a good deal of territory hitherto unknown. It was upon the return from the Pole, when almost in sight of Spitsbergen (in

81° 15' N. and 25° 20' E.) that the disaster occurred to the *Italia* which has given the expedition its tragic character. Russian, Swedish, French, and other assistance hurried by airplane and otherwise to the aid of the injured survivors on the pack ice, but it was only the powerful Russian ice breaker *Krasin* that was able to reach them.

Of the members of the expedition who drifted away in the burning balloon no trace has been found in spite of intensive search in 1928, 1929, and 1930. Amundsen lost his life in an airplane flight to the rescue—a tragic close to the career of this “supreme adventurer,” as he is called by his former comrade, Lincoln Ellsworth.⁴⁰

RESULTING PRESENT STATUS OF KNOWLEDGE

This brings down to date the account of current exploration within the Arctic Basin itself, leaving the status of knowledge as shown on the adjoining map (Fig. 6).

FLYING IN THE ARCTIC FOR PRACTICAL PURPOSES

In the lands bordering the Arctic Basin the practical application of flying has increasingly come to the fore, and, although not strictly exploration, these activities merit brief consideration here. Also, there have of course been exploring expeditions since 1925 not equipped with airplane or airship, and some of these should be mentioned to round out the record. Hence these two classes of undertakings will now be briefly passed in review in so far as they affect the Arctic within the limits of that region as defined below in Figure 8.

Expeditions and Flights for the Establishment of a Transatlantic Route

There are two main routes of least resistance between the Old World and the New. One, which may be called the “stepping-stone” route, goes by way of Iceland, Greenland, and Labrador; the other, best described as the trade-wind route, swings southward past the Canaries toward the Antilles and so on to the American

⁴⁰ Air Pioneering in the Arctic: The Two Polar Flights of Roald Amundsen and Lincoln Ellsworth, New York, 1929, p. 129.

coast. It is no mere chance that America was discovered by way of these two routes. And the same physical conditions that shaped the paths of Leif Ericsson and of Columbus are exerting their influence now, when the most feasible air routes between Europe and North America are being investigated.



FIG. 6—The present unknown areas (in gray) in the Arctic Basin. Scale 1:40,000,000.

Of course, establishing a feasible air route is not merely a question of joining the two ends by a great circle. Rather it is a question of knowing what the meteorological conditions are and then selecting a route that turns them to advantage. In this respect the era of flying is more closely related to the era of sails than to the era of steam, although obviously the airplane has greater independence of action than the airship, the true aerial counterpart of the sailing vessel.

While our knowledge of the meteorological conditions along the southern route is relatively complete that of conditions along the northern route is very deficient, mainly owing to the lack of enough observation stations in high latitudes. To secure fairly long series of records at critical places in this belt is the main purpose of a number of recent expeditions.

One of the leading exponents of the desirability of fuller knowledge of meteorological conditions in the area that is the most important and where they are least known, Greenland, is Professor W. H. Hobbs of the University of Michigan. His studies, dating back to 1910,⁴¹ led him to the recognition of the existence, over the two great remaining ice caps of Greenland and the Antarctic Continent, of fixed high-pressure areas with outward-blowing winds, termed glacial anticyclones, each of which exerts a fundamental control over the atmospheric conditions about it. To gather the necessary records he organized and has conducted four University of Michigan Greenland Expeditions.⁴² The first,⁴³ in 1926, did preliminary upper air work on Maligiak Fiord above Holsteinsborg on the west coast (67° N.); the second, in 1927, established a meteorological station called Mount Evans (about $66^{\circ} 55'$ N. and 51° W.), about 35 miles east of the camp of the first expedition and nearer the inland ice, two observers remaining for observations on the ice cap during the winter of 1927-1928; the third, in 1928, continued the observations at Mount Evans and helped in the rescue of the plane *Greater Rockford* which flew from Rockford, Illinois, via Cochrane, Ontario, to Greenland in August, 1928 (see below, p. 46); the fourth⁴⁴ started this summer (1930) and is divided into two parties, one party going to Upernivik on the west coast ($72\frac{3}{4}^{\circ}$ N.), where a house will be erected and upper-air and glacial studies carried on for a whole year, the second party going to Ivigtut in extreme southern Greenland (61° N.), where similar studies will be carried on.

Two further expeditions, a German and a British, are in the

⁴¹ W. H. Hobbs: *The Glacial Anticyclones: The Poles of the Atmospheric Circulation* (Univ. of Michigan Studies, Sci. Ser., Vol. 4), New York, 1926, p. 3.

⁴² W. H. Hobbs: *Exploring About the North Pole of the Winds*, New York, 1930.

⁴³ W. H. Hobbs: *The First Greenland Expedition of the University of Michigan*, *Geogr. Rev.*, Vol. 17, 1927, pp. 1-35.

⁴⁴ *Geogr. Rev.*, Vol. 20, 1930, p. 682.

field primarily to study meteorological conditions in their bearing on a transarctic air route. The German expedition,⁴⁵ consisting of about twenty persons including eight members of the scientific staff, is under the leadership of Professor Alfred Wegener of the University of Graz, Austria, and is expected to last eighteen months. It sailed from Copenhagen on April 1, 1930, and reached Holsteinsborg on the west coast in mid-April. Of the three stations planned the central one on the ice cap was established on July 31 at a point 250 miles from either coast (i.e. about in 71° N. and 40° W.), the material having been sledged up the Kamarujuk Glacier back of Umanak Fiord on the west coast. To find a suitable glacier for this purpose was the main object of a preliminary expedition by Professor Wegener in 1929.⁴⁶ The two other stations will be erected on the east and west coasts respectively in approximately the same latitude, at Scoresby Sound and Disko Bay. In addition to the meteorological work glaciological and geological studies will be undertaken, especially the measurement of the thickness of the ice cap by the new seismographic method perfected by Mothes. This is Professor Wegener's fourth expedition to Greenland, as he took part in the *Danmark* expedition of 1906-1908 to northeast Greenland and in 1913 made the crossing of the ice cap at its widest part with Captain J. P. Koch of the Danish Army.

The British expedition,⁴⁷ called the British Arctic Air Route Expedition, consists of twenty-three persons including twelve technical men besides the leader, Mr. H. G. Watkins, who carried out some useful winter exploration in the interior of Labrador in 1928-1929. The expedition sailed from London on July 6, 1930, on Shackleton's former vessel, the *Quest*, expecting to be gone about fourteen or fifteen months, and arrived at Angmagssalik on the eastern coast of Greenland ($65\frac{1}{2}^{\circ}$ N.) on July 26. The equipment included two De Haviland Moth airplanes. The main base was established on an arm of Sermilik Fiord, at the foot of which Angmagssalik lies, about 35 miles northwest of that settlement. By

⁴⁵ *New York Times*, May 4, 1930 (plans of expedition), and April 10, 18, May 9, June 21, 24, July 17, 22, 23, Aug. 23, Sept. 3, 17, 26, Oct. 15, 1930 (despatches from the field).

⁴⁶ A. Wegener and others: *Deutsche Inlandeis-Expedition nach Grönland*, Sommer 1929, *Zeitschr. Gesell. für Erdkunde zu Berlin*, 1930, pp. 81-124.

⁴⁷ *New York Times*, July 1, July 20, August 3, 1930 (plans of expedition), July 7, 16, 19, Aug. 15, 29, Sept. 11, 22, 1930 (despatches from the field).

means of a dog-sledge journey from here a meteorological station was erected on the ice-cap at the equivalent to the highest point (about 9000 feet) of De Quervain's crossing of 1912, or about 140 miles inland ($67^{\circ} 3' \text{ N.}$ and $41^{\circ} 48' \text{ W.}$). Observations will be recorded here continuously for a whole year. In addition dog-sledge trips are planned on the ice cap, one southward along shore and then back northward along its crest, another northward into its heart, and a crossing by sledge and airplane to Disko Bay. It is also proposed to survey by ship and airplane the coast northeast to Scoresby Sound more completely than has been done hitherto. On this stretch Kangerdlugssuak Fiord was recently surveyed and found to extend northwest 40 miles, heading in $68^{\circ} 50' \text{ N.}$ and $32^{\circ} 25' \text{ E.}$ The Canadian authorities and the Hudson's Bay Company are heartily coöperating with the expedition. Gasoline and food depots are being laid down at Pangnirtung in Cumberland Sound and Cape Dorset, Foxe Land (both in Baffin Island), Coral Harbor, Southampton Island, and Tavane Bay south of Chesterfield Inlet. Near this last locality Canadian government airplanes are engaged in surveying the west coast of Hudson Bay. At the end of the winter the Vickers Aviation Corporation expects to send an airplane for an experimental flight from England via the Faeroes and Iceland to the west coast of Greenland over the route that the expedition will have worked out.

The various expeditions just discussed are endeavoring to provide a stable basis for air routes in this region. But the pioneering spirit does not wait for security, and a number of hardy souls have attempted and some succeeded in flying this route. A mere enumeration of these flights, in so far as they relate to the Arctic as here defined, must suffice.

Part of United States Army Air Service world flight, August, 1924. Hydroplanes *Chicago* (Lieutenants L. H. Smith and L. P. Arnold) and *New Orleans* (Lieutenants E. H. Nelson and John Harding). Kirkwall (Orkney Islands)—Hornafjord (Iceland) — Reykjavik — Frederiksdal (Greenland) — Ivigtut (Greenland)—Icy Tickle (Labrador).*

Stinson-Detroit monoplane *Greater Rockford*, August, 1928 (B. R. J. Hassell and P. D. Cramer). Rockford, Ill.—Cochrane, Ont.—western edge of Greenland ice cap in $66^{\circ} 20' \text{ N.}$ and 50° W. via Fiskenaesset (63° N.) and

* Lowell Thomas: *The First World Flight*, Boston, 1925, Chapters 29-31.

western edge of ice cap north from 64° . Rescued after 14 days by third University of Michigan Greenland expedition at head of Southern Strömfjord, $66^{\circ} 10' N.$ and $50^{\circ} 50' W.$ †

Twin-motor Sikorsky hydroplane 'Untin' Bowler, July, 1929 (R. J. Gast, P. D. Cramer, Robert Wood). Chicago—Milwaukee—Sault Ste. Marie, Ont.—Remi Lake, Ont.—Great Whale (east coast of Hudson Bay)—Fort Chimo (Ungava Bay)—Port Burwell (Labrador). Plane sunk by floating ice at Port Burwell.

Dornier Wal hydroplane D-1422,‡ August, 1930 (Captain Wolfgang von Gronau, Eduard Zimmer, Fritz Albrecht, Franz Hack). Sylt Island (North Sea, Germany)—Trangisvaag (Faeroe Islands)—Reykjavik—Ivigtut—Cartwright (Labrador)—Queensport, N. S.—Halifax—New York.

† W. H. Hobbs: Exploring About the North Pole of the Winds, New York, 1930, map on front lining paper and text, Chapters 19-22.

‡ This is the same plane in which the members of the Amundsen-Ellsworth expedition of 1925 returned from $87^{\circ} 43' N.$ (see above, p. 36.)

Flying as an Aid in the Maintenance of Arctic Sea Routes

In addition to blazing its own trails across the Arctic the airplane is serving in the more prosaic task of making safer and more efficient the existing shipping lanes in the North. On the two main routes, the Hudson Bay route leading from the Atlantic into the heart of Canada, and the Kara Sea route from western and northern Europe into the interior of Western Siberia by way of the Ob and Yenisei Rivers, the airplane, together with the radio, have recently begun to act as aids to navigation.

Owing to the impending opening of the Hudson Bay Railway an expedition under the direction of the Canadian Department of Marine and Fisheries, Major N. B. McLean, officer in charge, was sent to Hudson Strait from July, 1927, to October, 1928.⁴⁸ Bases were established at Port Burwell, Nottingham Island, and Wakeham Bay, respectively at the eastern and western ends of the strait and in the center of its southern side, each base being equipped with two Fokker planes. From each base patrols were carried out on triangular routes arranged fanwise so as to cover the whole length of the strait at practically the same time. From October to January and from May to August flights were made on every day permitted

⁴⁸ Report of the Hudson Strait Expedition, 1927-28, N. B. McLean, Officer in Charge, [Dept. of Marine and Fisheries], Ottawa, 1929; Report on Civil Aviation and Civil Government Air Operations for the Year 1928, Dept. of National Defence, Ottawa, 1929, pp. 59-67.

by the weather, and during mid-winter, from January to May, every fourteen days. Oblique overlapping air photographs were made of the ice for stereoscopic interpretation. The observations showed that permanent ice formed progressively at the three bases from west to east on November 16, November 25, and December 3, and that the strait was practically clear of ice on July 11, 23, and 24.⁴⁹ The results of the expedition demonstrated the value and practicability of a chain of radio-equipped stations along the Hudson Bay route as aids to navigation. Permanent stations were established in the light of this information at the terminus of the railway at Churchill, on Nottingham Island, at Cape Hope's Advance at the western entrance to Ungava Bay, and on Resolution Island at the eastern end of the northern side of the strait.

Whereas the supervision of the Hudson Bay route is of recent date, the patrol of the Kara Sea route has been in operation for a considerable time.⁵⁰ Radio stations were established in 1912-1914, at the southwestern entrance to the sea, at Yugor Strait and on the northern end of Vaigach Island, and, on its western side, at Matochkin Strait, Novaya Zemlya; likewise on its southern and eastern borders, at Mora Sale on the west side of Yamal Peninsula (in 69° 43' N.) and on Dickson Island at the eastern entrance to Yenisei Bay.⁵¹ Each year at the beginning of the season an ice breaker and the hydroplane that accompanies it make a reconnaissance of ice conditions. Based on these observations and those of the radio stations, which are likewise meteorological stations, the commanding officer of the ice breaker indicates to the cargo-ship fleet what course to pursue to avoid ice, or, if the ice conditions require it, convoys the fleet to the mouths of the Siberian rivers.^{51a} The discovery of better harbors for transshipment of cargo to the river barges, on the Ob at Novyi Port (67° 45' N. and 73° 10' E.) and on the Yenisei at Igarka (67° 18' N.), 400 kilometers upstream, has greatly improved the service. These improvements and the

⁴⁹ Report of the Hudson Strait Expedition, p. 15.

⁵⁰ For the translation of Russian sources on which the following account of the Kara Sea and Siberian Sea routes and the later reference (p. 56) to recent work on the Siberian coast are based, the writer is indebted to Mr. V. Sovinsky of the American Geographical Society's staff.

⁵¹ Leonid Breitfuss: *Die Erforschung des Polargebietes Russisch Asiens . . . 1912-24, Ergänzungsheft No. 188 zu Petermanns Mitt.*, Gotha, 1925, pp. 65-66.

^{51a} In 1930 the convoy service was performed exclusively by airplanes (*New York Times*, Oct. 15, 1930).

greater safety assured by the ice patrol are indicated by the fact that until 1928 only one convoy expedition a year was necessary, whereas in 1929 twenty-six vessels required six convoys, and by the further fact that the insurance rates dropped from 7 per cent in 1921 to $2\frac{1}{4}$ per cent in 1929 for hulls and from 5 per cent to 0.8 per cent for cargoes.⁵²

In addition to the two main Arctic sea routes just discussed there is a third, minor, route that requires mention. This is the Siberian Sea route through Bering Strait around the eastern end of Siberia to the mouths of the Kolyma, Indigirka, Yana, and Lena Rivers. In Siberian domestic economy it may be characterized as the minor eastern counterpart of the Kara Sea route. The main function of the vessels that ply this route is to transport provisions and supplies to the sparse population of the Arctic coastal belt and to return with the products of their industry, mainly canned and salt fish and furs. Only at the western extremity of the route—the most difficult to reach—is there really an access to and an outlet from the interior of Siberia, namely by way of the Lena River, but the Yakutsk and other regions thus tapped are of less economic importance than those that can be reached by the Ob and Yenisei.

Trips have been made annually to the Kolyma since 1911 (except in 1918, 1920, 1921, and 1922, when political conditions interfered) and to the Lena since 1927, latterly often with digressions to Wrangel Island. The vessels used, the *Stavropol* (on the route to the Kolyma) and the *Kolyma* (to the Lena), are ordinary small cargo ships with reinforced bows. Owing to the lack until recently of ice-observing and reporting stations the possibility of being forced to winter in the ice is taken into account. Such imprisonment befell the *Kolyma* twice and the *Stavropol* three times.⁵³

It was on the 1926 trip of the *Stavropol*⁵⁴ that the colony of fifty-one Chukchis and nine Russians was established on Wrangel Island, by which action Russia's claim to the island (see below, p.

⁵² N. Voevodin: Morskoi put o Sibir (Sea route to Siberia), *Sovetskii Sever*, No. 3, Moscow, 1930, pp. 62-83; Charles Rabot: La Sibérie du nord ouverte au commerce maritime, *L'Illustration*, Paris, Dec. 28, 1929, pp. 810-811.

⁵³ A. Lavrov: Ekspeditsii S.S.S.R. i S.A.S.Sh. po okazaniyu pomoshchi *Stavropolyn* i *Nanuk* (Expeditions sent by U.S.S.R. and U.S.A. for the relief of the *Stavropol* and *Nanuk*), *Morskoi Sbornik*, Leningrad, 1930, pp. 57-65; reference on pp. 57-58.

⁵⁴ The State of the Ice in the Seas of the U.S.S.R., No. 2: The Winter 1925-26, pp. 43-44, with Map 17, Hydro-Meteorol. Section, Hydrogr. Dept., Leningrad, 1927 (in Russian).

68) was reaffirmed. On this occasion the vessel was equipped with a Junkers seaplane flown by the naval airman, Otto Kalvits.⁵⁵ An air reconnaissance was made of the island. In 1927 the island was reached by hydroplane from the *Kolyma* at Cape North ($179\frac{1}{2}^{\circ}$ W.).^{55a} In 1928 the *Stavropol*, after a trip to the Kolyma mouth and back, was balked by ice in an attempt to reach Wrangel Island.⁵⁶

In 1929 both the airplane and the ice breaker were resorted to in order to reach the new colony. As part of a remarkable 3000-mile flight⁵⁷ on a Junkers hydroplane to reconnoiter a feasible route to connect the government trading posts along the Arctic coast, air pilot Kalvits flew to Shalaurov at the mouth of the Kolyma, up that river to Nizhne Kolymsk and Sredne Kolymsk, thence north via the mouth of the Alazei River (154° E.) and west to Russkoye Ust at the head of the Indigirka delta, then along shore to Laptev Strait, which he crossed to Great Lyakhov Island. He returned to the mainland at Kazache at the head of the Yana delta and finally reached Bulun ($70\frac{3}{4}^{\circ}$ N.) on the Lena.

The ice breaker used was the *Fedor Litke* (Lütke).⁵⁸ Leaving St. Lawrence Bay, Chukchi Peninsula, on August 5, 1929, she avoided the heavier ice by passing north of Herald Island and skirting the eastern shore of Wrangel Island. Rodgers Harbor at the southeastern end was reached on August 29. Provisions and supplies for the colony were landed, including material to build a radio weather station.⁵⁹ The nine Russians were relieved and replaced by seven others. Leaving the island on September 5 the *Litke* was back in St. Lawrence Bay on September 10.

The 1929-1930 wintering of the *Stavropol* at Cape North was made especially eventful by the fact that it was in trying to take off the crew and cargo of the American fur-trading schooner *Nanuk*, ice-bound near by, that Carl B. Eielson, Wilkins' pilot on

⁵⁵ *New York Times*, Nov. 15, 1926.

^{55a} State of the Ice, etc., No. 3: Winter 1926-27, p. 56, with Map 17.

⁵⁶ State of the Ice, etc., No. 4: Winter 1927-28, pp. 62-64, with Map 28.

⁵⁷ V. O. K. S., 1930, No. 1-3, pp. 71-72, Society for Cultural Relations with Foreign Countries, Moscow.

⁵⁸ *Zapiski po Gidrogr.*, Vol. 58, pp. 71-72, Leningrad, 1929, and *Izvestiya Gos. Gidrogr. Inst.*, No. 25, pp. 110-112, Leningrad, 1929.

⁵⁹ In addition to the references of the previous note, see also L. Breitfuss: Die neuen Radio-Wetterstationen auf der Wrangelinsel und in Bulun, *Arktis*, Vol. 2, 1929, pp. 129-130.

his 1927 and 1928 Arctic and 1928 Antarctic flights, lost his life.⁶⁰ Early in November Eielson and Frank Dorbandt, flying in two airplanes from Teller, Alaska, to the *Nanuk*, had brought back six persons from that vessel. On November 9 they left Teller on a second trip, but Dorbandt returned in his plane on account of bad weather after flying westwards for one hour. No news being received about Eielson and his mechanic, Earl Borland, either in Alaska or Siberia, rescue expeditions by dog sledge locally and by airplane from Alaska, Canada, and Russia were organized. Pilots Harold Gillam and Joe Crosson, the latter co-pilot with Eielson on Wilkins' Antarctic expedition of 1928-1929, were the first in the field, reaching the *Nanuk* from Teller on December 23. Finally on January 25 they found the wrecked plane in the snow on the frozen lagoon at the mouth of the Anguema River ($177\frac{1}{2}^{\circ}$ W.). After days of digging, in which participated the crews of the *Stavropol* and of the two Canadian and two Russian planes from the *Liike* that had respectively arrived from Teller and Providence Bay several days before, the bodies were at last found near the plane in mid-February and transported by air to Nome and thence ultimately to Seattle.

Aerial Mineral Prospecting in Arctic Canada

In the last few years the airplane has been put to a special purpose in Arctic Canada, namely that of prospecting for minerals.⁶¹ In this it has proved invaluable, by making accessible all parts of the lake-studded Precambrian shield and by cutting down from weeks to hours the time consumed in reaching a given area. At first the airplane was used chiefly in the relatively simpler operations of reconnoitering for promising rock exposures from the air and of transporting small parties to individual localities deemed to be worthy of closer examination. In the last two or three years, however, elaborate expeditions have been organized, involving the establishment beforehand of gasoline bases and un-

⁶⁰ *New York Times*, Nov. 15, 1929, to March 30, 1930, especially Nov. 16, 1929, Jan. 27, Feb. 18 and 21, 1930.

⁶¹ G. H. Blanchet: Preliminary Report on the Aerial Mineral Exploration of Northern Canada, Northwest Territories and Yukon Branch, Dept. of the Interior, Ottawa, 1930; J. A. Wilson: Gentlemen Adventurers of the Air, *Natl. Geogr. Mag.*, Vol. 56, 1929, pp. 597-642.

dertaking a systematic exploration of large areas. Two of these expeditions may now be mentioned.

Two companies, the Northern Aerial Mineral Explorations, Ltd. (N. A. M. E.), and the Dominion Explorers, Ltd., went into the field in the spring of 1928 with a view to examining the area along the northwestern side of Hudson Bay. Each sent a vessel with supplies, the former the *Patrick and Michael* from St. John and the latter the *Morso* from Halifax. At the same time canoe parties were worked into the area from the west and airplanes from the south. The N. A. M. E. established a base at the foot of Baker Lake (about 64° N. and 94° W.), where its vessel had been wrecked. The Dominion Explorers organized their main base on the shore of Hudson Bay at a point in latitude 62° N. to which the name Tavane was given. During the season of 1928 a considerable portion of the bay coast was investigated, but it was in 1929 that the major explorations were carried out. These extended westward from a broadened front on the bay side reaching from Eskimo Point (61° N.) to Repulse Bay ($66\frac{1}{2}^{\circ}$ N.) entirely across the Barren Grounds to Bathurst Inlet and the mouth of the Coppermine River on Coronation Gulf. In this work an N. A. M. E. plane was forced down through lack of gasoline near the Arctic mainland coast, and the party was found only after some weeks' searching. A Dominion Explorers party consisting of two planes was likewise forced down on the Arctic coast, west of Ellice River near Melbourne Island ($104\frac{1}{2}^{\circ}$ W.), after having flown from Baker Lake on September 8. They left their planes there and, guided by Eskimo hunters whom they had met, crossed on foot the ice in Dease Strait to the Hudson's Bay Company's post at Cambridge Bay on the southern shore of Victoria Island, where they arrived on November 3. The long absence of this party led to numerous searching expeditions by airplane on which about 12,000 miles were flown and much information was gathered as to the topography of the area covered.

The waterways separating the mainland from the Arctic Archipelago were the scene of a recent noteworthy flight⁶² that, although not undertaken for mineral prospecting, should be mentioned here.

⁶² *New York Times*, Aug. 17, 24, 31, Sept. 10, 11, 13, 16, 21 (with map), 1930.

This flight was made by Major L. T. Burwash of the Northwest Territories and Yukon Branch to map photographically the magnetic pole area and to try to locate the last camps of the ill-fated Franklin expedition of 1845-1848. He started on August 23, 1930, from Fort Hearne at the mouth of the Coppermine River, with W. E. Gilbert as pilot, flew to Bernard Harbour on Dolphin and Union Strait and thence along the south coast of Victoria Island to King William Island, which he completely encircled, and made a digression to the magnetic pole area on Boothia Peninsula. New camp sites and new graves of the Franklin expedition were found on the west coast of King William Island. The return flight was made by the south shore of Victoria Island to Cambridge Bay and thence along the south shore of Dease Strait and Coronation Gulf. Fort Hearne was reached again on September 8. The entire length of coast line followed was mapped photographically.

SOME NON-FLYING ARCTIC EXPEDITIONS SINCE 1925

The preceding sections have attempted to show to what extent aircraft have been used as a means of exploring and developing the Arctic. Obviously much work, especially of a detailed nature, is still being done by ship and sledge, and it is merely to give some indication, however inadequate, of the range of this work that the present section is added. It in no way pretends to be complete or balanced nor even to represent a critical selection. Its only aim is to be suggestive.

In the American Arctic the Canadian Arctic Archipelago and especially Baffin Island have been the main scenes of activity. Notable in these areas are the patrols undertaken by the Royal Canadian Mounted Police in the normal line of duty. Many of these patrols, in hardships surmounted, areas visited, and work done, are the equivalent of widely known exploring expeditions. Yet even geographers know little of them. They are described in the Commissioner's annual report⁶³ but are, so far as known, never represented on a map in the service's own publications. It is only when so conspicuous a new feature as Makinson Inlet in southeastern Elles-

⁶³ Reports of the Royal Canadian Mounted Police—prior to 1920: (Royal) Northwest Mounted Police, first organized in 1873—for the years 1874 to 1929, Ottawa, 1875-1930.

mere Island, penetrating deeply inland back of the coast between Boger Point and Clarence Head as represented by Inglefield in 1852, Kane in 1854, and Hayes in 1861, appears on a map⁶⁴ that investigation discloses it as due to the work of the R. C. M. P., in this case the patrol of Constable G. T. Makinson in April, 1928;⁶⁵ or when a small map in the publication of another bureau⁶⁶ represents it that proper attention is called to the remarkable patrol of Inspector A. H. Joy, with one constable and one Eskimo, covering 1700 miles in the 81 days between March 12 and May 31, 1929, from Dundas Harbor on Devon Island, along the south shores of Cornwallis and Bathurst Islands, to Winter Harbor on Melville Island, thence across that island and by way of Lougheed and Ellef and Amund Ringnes Islands to Axel Heiberg Island and by way of Eureka Sound and the Bay Fiord crossing of Ellesmere Island to the post at Bache Peninsula.⁶⁷

As regards Baffin Island, which has recently received monographic treatment,⁶⁸ the outstanding recent explorations are those by J. D. Soper,⁶⁹ lately of the National Museum of Canada, Department of Mines, Ottawa, and by the Putnam Baffin Island Expedition of 1927.⁷⁰ The latter, which first revealed the true position of the northern coast of Foxe Peninsula and the deep reëntrant at the southeastern corner of Foxe Basin, illustrates the need for the prompt publication of scientific results, a point which merits brief mention. After the return of the expedition it became apparent that points on this coast had been occupied and astronomically determined for magnetic observations by the MacMillan expedition of 1922,⁷¹ but there seems to have been no published evidence of the realization of the new discovery defined by these positions.

⁶⁴ Map of the Northwest Territories, 1:3,801,600, Northwest Territories and Yukon Branch, Dept. of the Interior, Ottawa, edition of 1929.

⁶⁵ Report of Royal Canadian Mounted Police for 1928, Ottawa, 1929, pp. 66-67.

⁶⁶ "The Northwest Territories, 1930," Northwest Territories and Yukon Branch, Dept. of the Interior, Ottawa, 1930, p. 126. (This bureau is issuing an increasing number of valuable general reports which are remedying the defect indicated above.)

⁶⁷ Report of Royal Canadian Mounted Police for 1929, Ottawa, 1930, pp. 62-71.

⁶⁸ Southern Baffin Island: An Account of Exploration, Investigation, and Settlement During the Past Fifty Years, Northwest Territories and Yukon Branch, Ottawa, 1930.

⁶⁹ *ibid.*, pp. 67-83, and *Geogr. Rev.*, Vol. 20, 1930, pp. 397-424.

⁷⁰ *Geogr. Rev.*, Vol. 18, 1928, pp. 1-40.

⁷¹ "Baffin Island No. 3," 65° 23.9' N. and 77° 33' W.; "Baffin Island No. 5," 65° 24.4' N. and 76° 41' W.; "Baffin Island No. 6," 65° 19.9' N. and 75° 54' W., *Researches Dept. Terrest. Magnet.*, Vol. 6, pp. 62 and 253, Carnegie Instn., Washington, 1927.

Another case of unknown priority because of lack of publication is Crawford Noble Jr.'s trip around Nettilling Lake in 1902, which preceded Hantzsch's work by nine years but an account of which has only now been printed.⁷²

Proceeding eastward, mention should be made of the *Marion* expedition of the U. S. Coast Guard in 1928 in the waters of Davis Strait and Baffin Bay.⁷³

In Greenland, besides the expeditions mentioned above (pp. 44-46), outstanding work has been done by the well-known Danish geologist, Dr. Lauge Koch, in 1926-1927⁷⁴ and 1929 in eastern Greenland.⁷⁵ The 1923, 1926, and 1929 East Greenland expeditions of Cambridge University under the leadership of J. M. Wordie had the alpine region about Petermann Peak (73° N.) at the head of Franz Josef Fiord as their objective.⁷⁶ Dr. J. B. Charcot utilized his former Antarctic vessel, the *Pourquoi Pas?*, for cruises in the Greenland Sea in 1925, 1926, and 1928.^{76a}

Turning now to the Eurasian Arctic⁷⁷ we may first briefly refer to the Worsley-Algarsson expedition of 1925⁷⁸ to the northern edge of Barents Sea, which corrected the position of the east coast of Northeast Land in the Spitsbergen group and of White and Victoria Islands, and to the official Russian expeditions of the ice breaker *Sedov* to Franz Josef Land in 1928,⁷⁹ 1929, and 1930. On the 1929 expedition a meteorological station equipped with wireless was established in 80° 19' N. and 52° 48' E. on Hooker Island—the northernmost observatory in the world.⁸⁰ On the 1930

⁷² Work cited in footnote 68, pp. 36-39.

⁷³ E. H. Smith: Expedition of U. S. Coast Guard Cutter *Marion* to the Region of Davis Strait in 1928, *Science*, Vol. 68, 1928, pp. 469-470; *idem*: Narrative Account of the "Marion" Expedition, *Hydrogr. Rev.*, Monaco, Vol. 6, 1929, pp. 197-203; *idem*: Arctic Ice, With Especial Reference to Its Distribution in the North Atlantic: The *Marion* Expedition to Davis Strait and Baffin Bay Under the Direction of the United States Coast Guard, 1928, Scientific Results, *U. S. Coast Guard Bull. No. 19*, Part 2, Washington, in press, 1930.

⁷⁴ Lauge Koch: Report on the Geological Expedition to East Greenland, 1926-1927, *Meddelelser om Grønland*, Vol. 76, pp. 225-282, Copenhagen, 1930.

⁷⁵ *idem*: The Danish Expedition to East Greenland in 1929, *ibid.*, Vol. 74, pp. 173-205, Copenhagen, 1930.

⁷⁶ *Geogr. Journ.*, Vol. 75, 1930, pp. 481-504.

^{76a} J. B. Charcot: La Mer de Groenland: Croisières du *Pourquoi Pas?*, Paris and Bruges, 1929; *idem*: Rapport préliminaire sur la campagne du *Pourquoi Pas?* en 1925, *Annales Hydrogr.*, No. 715, pp. 190-289, Paris, 1926;—en 1926, *ibid.*, No. 718, pp. 1-97.

⁷⁷ Recent expeditions and work in the European Arctic (1913-1928) are exhaustively discussed by L. Breitfuss in *Geogr. Jahrbuch*, Vol. 44 for 1929, Gotha, 1930, pp. 289-374.

⁷⁸ F. A. Worsley: Under Sail in the Frozen North, London, 1927, with map.

⁷⁹ N. Evgenov in *Morskoi Sbornik*, Leningrad, Feb., 1929, pp. 43-54, with map.

⁸⁰ W. Wiese in *Arktis*, Gotha, Vol. 2, 1929, pp. 126-128, and R. Samoilowitsch in *Petermanns Mitt.*, Vol. 76, 1930, pp. 136-137, with map.

expedition⁸¹ two new islands were discovered, one cape of the larger of which lies in 79° 25' N. and 76° 10' E. These islands seem to form part of an archipelago previously conjectured by Wiese on the basis of a study of the northward drift of the *St. Anna* of the Brusilov expedition of 1912-1914.⁸² One island was named Wiese Island and the other Kamenev Island. On the larger island (Kamenev Island) a house was built and fuel and supplies left there sufficient for three years. Four men remained on the island to spend the winter of 1930-1931. The Soviet flag was raised on the island and the group claimed for Russia.

In the region of the Ob and Yenisei estuaries the needs of the Kara Sea traffic have led to the resurvey of the shallow bays and low sandy offshore islands in which these river mouths abound, the outlines of which on recent maps are still in many cases derived from the work of the Great Northern Expedition of 1734-1743, of which Bering's expedition was a part.⁸³ The drainage of the lowland area⁸⁴ tributary to Taz Bay and the left bank of the lower Yenisei as well as the topography of the Taimyr Peninsula⁸⁵ were clarified by expeditions of the Academy of Sciences. Farther eastward the Yana, Indigirka, and Kolyma Rivers were resurveyed;⁸⁶ likewise Kotelny and Great and Little Lyakhov in the New Siberian Islands. On Great Lyakhov a geophysical observatory was established in 1928 which is equipped with wireless.⁸⁷

⁸¹ *New York Times*, Aug. 3, 5, 11, 16, 31, Sept. 8, 14, 16, 1930.

⁸² Breitfuss in *Ergänzungsheft No. 188 zu Petermanns Mitt.*, Gotha, 1925, pp. 55-57, based on W. J. Wiese (V. Y. Vize) in *Bull. Hydro.-Meteorol. Central Bureau*, 1924, No. 3 (in Russian).

⁸³ A. M. Lavrov, *Izvestiya Gos. Russ. Geogr. Obshchestva*, Vol. 60, 1928, pp. 323-326; I. P. Tolmachoff [Tolmachev], *Arktis*, Vol. 2, 1929, pp. 120-126; B. A. Sergeevskii, *Severnaya Aziya*, Moscow, 1928, No. 5-6, pp. 167-173, and *Zapiski po Gidrogr.*, Vol. 57, 1929, pp. 55-63.

⁸⁴ *Uralskoe Kraevedenie*, Vol. 2, 1928, pp. 129-135, Sverdlovsk; *Osved. Byull.*, No. 9 (April 20, 1929), pp. 68-71, No. 11 (May 10, 1929), pp. 84-87, Comm. on Expeditions, Acad. of Sci., Leningrad.

⁸⁵ *Osved. Byull.*, No. 7 (March 25, 1929), pp. 51-52; A. Tolmatschew, *Arktis*, Vol. 2, 1929, pp. 33-38, with map, Pl. 3.

⁸⁶ *Osved. Byull.*, No. 5-6 (March 15, 1929), pp. 35-38; *ibid.*, No. 18 (Sept. 10, 1929), pp. 143-144.

⁸⁷ *ibid.*, No. 17, pp. 135-136; No. 18, p. 144; *Arktis*, Vol. 2, 1929, pp. 129-130.

AIR NAVIGATION IN THE POLAR REGIONS¹

Although the airplane and the airship have introduced new tools which greatly facilitate the work of exploration, the special conditions under which they operate have created new problems in navigation. The speed and relative instability of these ships of the air make necessary modifications of the traditional methods of position finding and steering a course used on land or water. These modifications are required by air navigation in general, but flying in the Polar Regions calls for special methods in addition. It is only necessary to remember the exceptional course of the lines of equal magnetic variation in the Arctic and Antarctic and the low path of the sun in high latitudes during the six months that it is above the horizon to be aware of the limitations imposed on the customary use of the compass and sextant.

The two main operations involved in navigation are finding one's position and steering a course, and we will therefore briefly consider how these are carried out in the Polar Regions.

POSITION FINDING

The three most usual methods are by dead reckoning, by position-line determination, and by radio bearings. These three methods are most useful when used in conjunction.

By Dead Reckoning

This is simply the process of determining position by distance and direction flown from a known starting point. The method is applicable to air navigation anywhere and does not require a special modification for the Polar Regions. Its accuracy depends on the ability of the navigator to judge ground speed and to correct for drift. To do these things it is necessary to know the air speed, the altitude of the aircraft, and to be able to see the surface, which should not be featureless, as is the open sea. The Arctic pack ice

¹ Based mainly on, and paraphrased from, publications by O. M. Miller of the School of Surveying of the American Geographical Society, especially: Air Navigation Methods in the Polar Regions, in "Problems of Polar Research," *Amer. Geogr. Soc. Special Publ. No. 7*, 1928, pp. 445-456.

and the Antarctic inland ice fulfill the last requirement. Admiral Byrd used this method on his flight to the North Pole.

By a Position-Line Method

A far more accurate determination of position can be made by introducing the position-line method as a check on the navigator's dead reckoning. Because of the speed of aircraft, making it necessary for the navigator to determine his position practically on the instant, most traditional astronomical methods are valueless. The position-line method meets the requirement of speed and is especially adapted to use in high latitudes.

Suitable materials are a chart on a polar projection graduated on its circumference both for longitude and time, a set of curves calculated for the chart to be used, and a sextant. Without going into details, suffice it to say that the elements to be determined are the sun's elevation and the time of observation. Based on the values derived from these elements, a position line may be drawn on the chart by means of the suitable curve, or the location of two points on the position line near the assumed route may be deduced from tables provided the navigator. A small section of the required position line can then be drawn on the chart by drawing a straight line through these points. Other fairly short methods are available for doing the same thing, but the first mentioned is probably the quickest and is sufficiently accurate for the purpose in view. The line drawn represents a line at some point on which the aircraft was located at the time of observation. The point itself is found by plotting the estimated course flown from the preceding point of observation as determined by dead reckoning. The intersection of the course and the position line represents the location of the aircraft.

This method was used by Wilkins on his Alaska-Spitsbergen flight. It is especially suited to flying obliquely across meridians, which is what usually takes place in the normal case of flying from one given point to another, as compared with the specialized case of flying along a meridian, as to the North Pole or the South Pole. The plotting of Wilkins' route is shown on Figure 4 (p. 39), on a reduced facsimile of an Arctic navigational chart, prepared by the

American Geographical Society for use with this method. A similar chart of the Antarctic has been published by the Society.

By Radio Bearings

Two systems are in use. The first is for the aircraft to send out a signal whose respective direction from two or more ground stations is determined by them on receiving these signals. These direction lines when plotted on a chart should all intersect at a point, which is naturally the position of the aircraft. The ground stations then signal this position to the craft. The second system is for the aircraft to determine the direction of signals sent out from ground stations and plot the craft's position itself. During her transpolar flight the *Norge* obtained checks on position by means of radio signals sent out from Kings Bay, Spitsbergen, and Nome, Alaska.

STEERING A COURSE

Steering a course is a part of the larger problem of direction finding. The most accurate method of direction finding in the Polar Regions is by the use of sun azimuth tables or by means of the sun compass; a practical method of steering a course is by ranging in. But for practical purposes when possible navigators prefer to use the magnetic compass.

Direction Finding by the Use of Sun Azimuth Tables

The elements needed are one's approximate position, the Greenwich apparent time (and consequently the difference in longitude between the position and the heavenly body observed), the declination of the heavenly body, and the latitude of the observer. Perhaps the simplest method of determining the azimuth from these data is by applying to the sun's hour angle from tables previously computed a small quantity dependent on the latitude of the observer and the declination of the sun.

Direction Finding by Sun Compass

The same principle is employed in the construction of the sun compass. In this instrument clockwork mechanism compensates

for the gradual change in hour angle. Sun compasses were used on the Amundsen-Ellsworth airplane flight of 1925, the trans-polar flight of the *Norge* in 1926, and Byrd's flight to the North Pole.

Steering a Course by Ranging In

Inasmuch as astronomical and ordinary magnetic methods, although used extensively for finding direction, are not entirely practical for steering a course, most navigators in the absence of fog prefer to steer a straight course by means of ranging in on natural objects or by taking back sights on smoke bombs dropped in the course of the flight. The first of these methods is quite practical over an ice field, as has been shown by Admiral Byrd and Sir Hubert Wilkins. In fog, however, the only practical method is to use a magnetic compass, preferably an earth-induction compass. In areas where they have been established radio beacons provide a solution for the problem of navigating in fog, but for the time being the polar explorer can hardly count on this form of guidance.

POLITICAL SOVEREIGNTY IN THE ARCTIC AND ANTARCTIC: RECENT DEVELOPMENTS

THE revival of polar exploration and the demonstration of the value of the Polar Regions in terms of their natural resources and in relation to shorter-distance world air routes have of course also brought about the desire to do away with vagueness as to sovereignty. In the Arctic, all known land has been taken into account, either by international agreement or by the claims of a given nation. In the Antarctic, however, the question is still far from settled, nor can it be otherwise in view of the vast areas still unexplored.

The Arctic

Omitting the only two countries that project into the Arctic through their home territory, viz. Iceland and Finland, there are five nations that may be considered to divide the Arctic among themselves: the United States, Canada, Denmark, Norway, and Russia. On the accompanying map (Fig. 7) the extent of their respective sectors is shown, distinction being made between limits of sovereignty defined by international agreement (full lines) and limits of claims put forth by the claimant nation. It is well to bear in mind that, as stated in the legend, sovereignty and claims relate only to lands (and their territorial waters) within the indicated limits. The treaty or declaration defining a given boundary is cited along that boundary on the map. Hence it is not necessary here to discuss each sovereignty one by one, especially as valuable references already exist.¹ However, three territories may be discussed

¹ D. H. Miller: Political Rights in the Polar Regions, in "Problems of Polar Research", *Amer. Geogr. Soc. Special Publ. No. 7*, New York, 1928, pp. 235-250.

Leonid Breitfuss: O razgranichenii severnoi polyarnoi oblasti (The subdivision of the Arctic), *Morskoi Sbornik*, Leningrad, 1927, No. 1, pp. 3-13.

Leonid Breitfuss: Die territoriale Sektoreinteilung der Arktis im Zusammenhang mit dem zu erwartenden transarktischen Luftverkehr, *Petermanns Mitt.*, Vol. 74, 1928, pp. 23-28 (translated by M. B. A. Anderson and R. M. Anderson as "Territorial Division of the Arctic", *Dalhousie Rev.*, Vol. 8, 1928-29, pp. 456-470, Halifax, N. S.).

V. L. Lakhtin: Prava na severnye polyarnye prostranstva, etc. (Rights over the Arctic Regions: Analysis of the political, economic, and legal status of the Arctic Regions in connection with the development of aerial navigation and transarctic flights), Commissariat of Foreign Affairs, Moscow, 1928.

Adolf Hoel: Suverænitetsspørsmålene i polartraktene, *Nordmands-Forbundet*, Vol. 21, 1928, pp. 79-84 and 131-136, Oslo.

Footnote continued on next page

whose political status has undergone a definite change since 1925, viz. Fridtjof Nansen Land, Wrangel Island, and Jan Mayen.

CONSOLIDATION OF RUSSIAN TERRITORY

Fridtjof Nansen Land (formerly Franz Josef Land)

Prior to the World War Franz Josef Land may be considered a no man's land. Any claims that Austria-Hungary might have had to the archipelago by right of discovery² and exploration by Payer and Weyprecht in 1873 were not substantiated by further acts of sovereignty and in any case would probably have lapsed as a result of the war. During the war, Russia, in a note³ dated September 4, 1916, informed the Allied and friendly powers of the incorporation in the territory of the Russian Empire of the islands discovered on the northern hydrographic expeditions under Vilkitski in 1913 and 1914 (Northern Land and Little Taimyr, Starokodonski, Vilkitski, and Zhokhov Islands, to use their present names). The note went on to state that Russia considered as belonging to her Henrietta, Jeannette, Bennett, Herald, and Lonely Islands, "which, together with the New Siberian Islands, Wrangel Island, and others lying near the Asiatic coast of the Empire, constitute a northward extension of the continental platform of Siberia". The note concluded by saying that it is not deemed necessary to make a specific declaration with regard to Novaya Zemlya, Kolguev, Vaigach, and other smaller islands lying near the European coast of the Empire as they have for centuries been recognized as belonging to Russia.

No mention, it will be noted, is made of Franz Josef Land; and the circumstance that the note, in the part that deals with the European sector, refers only to islands lying near the coast would

Gustav Smedal: Erhvervelse av statshöihet over polaromraader, Oslo, in press 1930.

Typewritten minutes of the General Conference on Problems of Sovereignty in the Arctic and the Antarctic (Dr. Laura H. Martin, Chairman) held at the Institute of Politics, Williamstown, Mass., August 4-5, 1930 (available through the courtesy of Dr. Martin). Reports on the conference appeared in the *New York Times*, August 5 and 6, 1930.

² Dr. Gunnar Horn, in his work on the exploration of Franz Josef Land cited below, p. 65, footnote 13, states (pp. 11 and 32) that the archipelago was discovered eight years earlier, in 1865, by the Norwegian sealer Rönnbeck and the harpooner Aidijärvi, sailing from Hammerfest in the schooner *Spidsbergen*. "They called the country Northeast Spitsbergen. No importance was attached to their discovery, which never became generally known."

³ Text in *La Géographie*, Vol. 31, 1916-17, p. 393.

seem to make it probable that a definite stand with regard to that archipelago was not contemplated. However, two years before, after the outbreak of the World War and as a measure induced by that event, the Russian flag had been raised at Cape Flora, southwestern Northbrook Island (80° N. and 50° E.) on August 29,

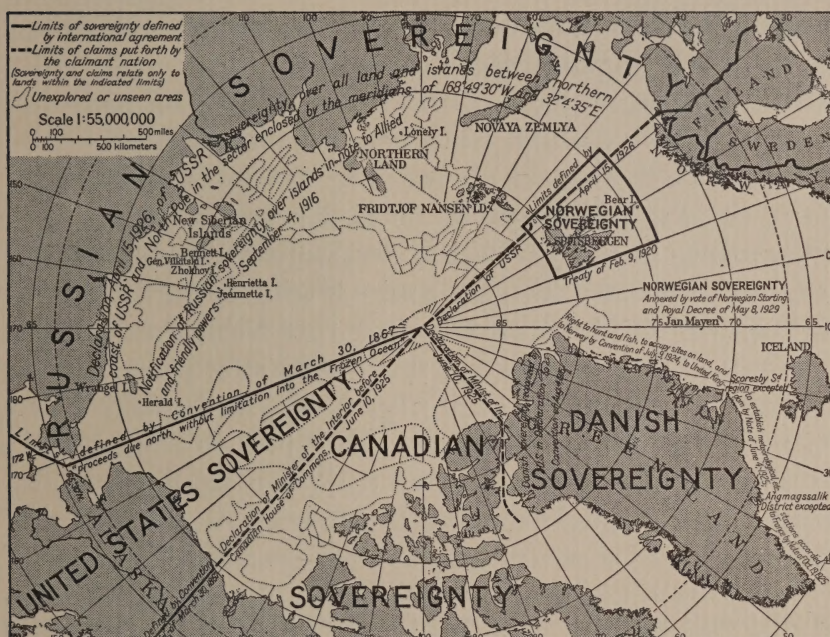


FIG. 7.—Map showing the limits of political sovereignty and claims in the Arctic. Scale 1:55,000,000. The basis for a given sovereignty or claim is stated on the map in the area or along the boundary to which it applies. Note that sovereignty and claims relate only to the lands (and their territorial waters) within the indicated limits. Unexplored areas are bounded by a dotted line (these are shown in gray on Fig. 6).

1914, and Franz Josef Land had been declared annexed to Russia by the expedition organized and sent by the Russian Navy under I. I. Islyamov for the relief of the Sedov, Brusilov, and Rusanov expeditions.⁴

During the first years of the Soviet régime Franz Josef Land seems to have been considered as not belonging to Russia, if the representation on a number of official maps may be deemed

⁴ M. Zhanko in *Zapiski po Gidrogr.*, Vol. 38, No. 4, Petrograd, 1914, p. 17; N. Evgenov in *Morskoj Sbornik*, Leningrad, 1929, No. 2, pp. 43 and 45; Samoilowitsch, p. 373 of work cited in footnote 9, below.

evidence.⁵ Possibly impelled by the Wrangel Island affair (see below, pp. 66-69) the Central Executive Committee of the U. S. S. R. on April 15, 1926, promulgated a decree⁶ to the effect that all lands and islands discovered or to be discovered between the Arctic coast of the U. S. S. R. and the North Pole in the sector between the meridians of $168^{\circ} 49' 30''$ W. and $32^{\circ} 4' 35''$ E. and not acknowledged by the Soviet government to be foreign territory were thereby declared to belong to Russian sovereignty.⁷

With regard to Franz Josef Land the following steps were taken to put this declaration into effect. On the *Sedov* expedition of 1928 (see above, p. 55) to search for the group of the Nobile party that had drifted away in the airship (see p. 42) a landing was made on August 5 at Cape Lofley, southern Alexandra Island ($80^{\circ} 25'$ N. and 44° E.), and a cairn bearing the Soviet emblem was erected.⁸ On the second trip of the 1928 Nobile rescue expedition on the *Krasin* undertaken in search of the same group a landing was made on September 22 at Cape Neale, southwestern Prince George Island ($80\frac{1}{4}^{\circ}$ N. and $46\frac{2}{3}^{\circ}$ E.), provisions left, and the Russian flag raised.⁹ In 1929, on the *Sedov* expedition of that year, a meteorological station was established in August on Hooker Island, as stated above (p. 55), the buildings erected consisting of

⁵ Map of the Ways of Communication of the R.S.F.S.R., prepared in 1917 by the Statistical and Cartographic Section, published by the People's Commissariat of Ways of Communication, Petrograd, 1923, 1:6,300,000 (in Russian); Map of the Union of S. S. R., prepared by the Map Publishing Office of the People's Commissariat of the Interior, Moscow, 1:6,000,000 (in Russian), e.g. 3rd edition, with administrative divisions as of Sept. 15, 1926. That the latter map under date of Sept. 15, 1926, represents Franz Josef Land as non-Russian in spite of the decree of five months earlier, to be referred to immediately, may be due to lag or to lack of coördination among different government bureaus.

⁶ Quoted in Breitfuss, *Die territoriale Sektoreneinteilung*, p. 27. The 9th edition (as of Nov. 10, 1929) of the 1:6,000,000 map referred to in the preceding footnote specifically shows as the limits of the Arctic possessions of the U.S.S.R. the two meridians mentioned and cites the decree as the basis of this delineation. So does a new official map of the political divisions of U. S. S. R., 1:15,000,000, 1930.

⁷ The meridian of $168^{\circ} 49' 30''$ W. passes between two small islands in the Diomedea group in Bering Strait and is the same one that was used in the Convention of March 30, 1867, to define the line between United States and Russian territory at the time of the purchase of Alaska. But the meridian of $32^{\circ} 4' 35''$ E. cuts right across the trapezoid defining the limits of Norwegian sovereignty (long. 35° on the east) over Spitsbergen and adjacent islands in the Treaty of February 9, 1920 (Fig. 7). Since her recent adherence to this treaty Russia evidently recognizes the 35th meridian as the boundary between Russian and Norwegian sovereignty in the latitude where land exists, i.e. about $80^{\circ} 10'$ N. At least the new physical Map of the U. S. S. R., 1:5,000,000, compiled by the Cartographic Department of the Geodetic Committee of the Supreme Council of Public Economy of the U. S. S. R., Moscow, 1929, shows an eastward protuberance from the $32^{\circ} 4' 35''$ boundary to 35° , leaving White Island to Norway and Victoria Island to Russia.

⁸ Evgenov, *Morskoi Sbornik*, 1929, No. 2, pp. 49-50.

⁹ R. Samoilowitsch: S-O-S in der Arktis: Die Rettungsexpedition des *Krasin*, Berlin, n.d., p. 376; Breitfuss, *Petermanns Mitt.*, Vol. 75, 1929, p. 74; *New York Times*, Sept. 25, 1928.

a twelve-room observatory with living quarters for the seven men left on the island for the winter of 1929-1930, a bathhouse, and a storehouse. On the cruise among the islands of the archipelago undertaken by the *Sedov* during the building operations, landings were made at two places on Crown Prince Rudolf Island, the northernmost island, and tablets were erected to the memory of polar explorers who had died there, Lieutenant Sedov (1914) at Cape Brorok and three members of the Duke of the Abruzzi expedition of 1899-1900 at Teplitz Bay. On the approach to the archipelago landings had also been made on the southern shore of Hooker Island, where the Soviet flag was raised on July 28,¹⁰ and at Cape Flora. On the 1930 expedition of the *Sedov* (see above, p. 56) the men of the meteorological station were relieved and replaced by the party, which includes a woman geographer, that is to spend the winter of 1930-1931 there. Alger Island was visited and the Soviet flag raised at Camp Ziegler (81° 21' N. and 56° 5' E.) of the Baldwin-Ziegler and Fiala-Ziegler expeditions of 1901-1902 and 1903-1905, respectively.¹¹ As a result of the death of Nansen on May 13 the Russian Academy of Science on June 1, 1930, voted to rename the archipelago Fridtjof Nansen Land,¹² and this has been its official designation since that time.

Such are the steps taken by Russia in pursuance of her declaration of sovereignty. There is one country, however, that does not recognize this sovereignty. After it had become known in the summer of 1928 that Russia was planning the erection of a meteorological station and as a result of the raising of the flag in September by the *Krasin* expedition, Norway, in a communication of December 19, 1928, from the Ministry of Foreign Affairs to the Soviet minister in Oslo, protested against the decree of April 15, 1926.¹³ Norwegian interest is based principally on the walrus, polar bear, and seal hunting that Norwegian sealers, mainly from Tromsø and Hammerfest, have been carrying on for the last sixty years. Of a recorded total of 136 expeditions from Weyprecht

¹⁰ Samoilowitsch, *Petermanns Mitt.*, Vol. 76, 1930, p. 136; Lavrov, *Zapiski po Gidrogr.*, Vol. 57, 1929, p. 67.

¹¹ *New York Times*, July 5, Aug. 3, 5, 1930.

¹² Associated Press despatch from Moscow, June 1, 1930 (e.g. *New York American*, June 2, 1930).

¹³ Gunnar Horn: Franz Josef Land: Natural History, Exploration and Hunting (Skrifter om Svalbard og Ishavet No. 29), Norges Svalbard og Ishavs Undersøkelser, Oslo, 1930, p. 32.

and Payer down to and including 1928, 109 were from Norway and 27 from other countries; and in the nine years beginning with 1920 there have been 44 Norwegian (14 in 1928 alone) to 8 non-Norwegian expeditions (of which seven were Russian and one was British).¹⁴ In addition Norway might advance the newly disclosed discovery by Rönnebeck and Aidijärvi as a claim. However, the actual occupation of the archipelago by Russia is an accomplished fact. Possibly a solution might be found by according Norway special hunting and sealing privileges similar to those accorded her by Denmark on the east coast of Greenland by the Convention of 1924.¹⁵

Wrangel Island

Wrangel Island, it might not unfairly be said, has been more definitely in Russian consciousness than Franz Josef Land. The declaration of September 4, 1916, illustrates this. Although the archipelago is not mentioned at all the island is named specifically, albeit, in the phrase used, the claim of sovereignty is left to inference rather than stated precisely. This more definite consciousness as regards Wrangel Island is mainly due to its greater nearness to the mainland coast. Contiguity is the underlying theory of the declaration, and it was due to contiguity that it had long been reported by the natives that land was to be seen on clear days from the Siberian coast north of Cape Yakan (177° E.)—land that Baron Ferdinand Wrangel had been unable to reach during his expedition of 1823. Wrangel Island was first sighted probably by Captain Kellett of the British Navy from Herald Island in 1849. Its actual survey and ground exploration are an American achievement, from the offshore survey on August 14-16, 1867, of its southern coast by Captain Thomas Long (bark *Nile* of New London),¹⁶ who gave the island its name, to the landing on its southeast shore by a party from the U. S. Revenue Steamer *Corwin* (Captain C. L.

¹⁴ Gunnar Horn, *op. cit.*, pp. 36-37.

¹⁵ Problems of Polar Research, *Amer. Geogr. Soc. Special Publ. No. 7*, New York, 1928, p. 235, footnote 1.

¹⁶ J. E. Nourse: American Explorations in the Ice Zones, Boston, 1884, pp. 458-462 (from the *Honolulu Commercial Advertiser*, Nov., 1867). The track survey is shown on U. S. Hydrogr. Office Chart No. 68, edition of July, 1868.

Hooper)¹⁷ on August 12, 1880, and the survey of the whole island, including exploration in the interior, by the officers of the U.S.S. *Rodgers*, Lieutenant R. M. Berry commanding, on August 25-September 13, 1881.¹⁸ On the occasion of the landing from the *Corwin* the American flag was raised and possession was taken in the name of the United States. No attempt seems to have been made to validate this claim, and indeed it is doubtful whether a claim could have been advanced in view of the wording of the Convention of 1867 as regards the limit between United States and Russian possessions. At any rate Russian official opinion before the World War, if a government map¹⁹ may again serve as evidence, seems to have considered Wrangel Island to be Russian territory. It may be due to this assumption that, when a beacon was erected at the western end on September 15, 1911, by a party from the *Vaigach* of the northern hydrographic expedition, although this was the first time Russians had set foot on the island, no formal ceremony of annexation seems to have been carried out.

It was the succeeding events that brought about Russian assertion of sovereignty. From March 12, 1914, until their rescue on September 7, 1914, the survivors from the sinking of the *Karluks* of the Canadian Arctic Expedition lived on Wrangel Island. Without knowledge of the Russian landing in 1911 the Canadian flag was raised on July 1, 1914, and the island was claimed for the British Empire on the basis of Kellett's probable discovery in 1849.²⁰ Convinced of the importance of the Arctic for the development of direct transpolar air routes between the population centers of north temperate lands,²¹ Vilhjalmur Stefansson, leader of the Canadian Arctic Expedition of 1913-1918, organized and sent an

¹⁷ C. L. Hooper: Report of the Cruise of the U. S. Revenue Steamer *Thomas Corwin* in the Arctic Ocean, 48th Congr., 1st Sess., Senate Exec. Doc. No. 204, Washington, 1884; John Muir (naturalist of the expedition): The Cruise of the *Corwin*, Boston, 1917.

¹⁸ Ann. Rept. of the Secretary of the Navy for 1881, Washington, 1881, pp. 755-763 of Appendix 17, with three maps, also published as U. S. Hydrogr. Office Charts Nos. 906, 907, and 908, edition of Dec. 1881 (last edition, as combined Chart No. 906, July 1918). See also W. H. Gilder: Ice-Pack and Tundra, New York, 1883, Chapters 6 and 7.

¹⁹ Map of the Ways of Communication of the Russian Empire, 1:12,600,000, Statistical and Cartographic Section, St. Petersburg, 1910 (in Russian).

²⁰ R. A. Bartlett: The Last Voyage of the *Karluks*, Boston, 1916, especially p. 321; Vilhjalmur Stefansson: The Adventure of Wrangel Island, New York, 1925, especially pp. 60, 25, and 414-415.

²¹ Vilhjalmur Stefansson: The Arctic as an Air Route of the Future, *Natl. Geogr. Mag.*, Vol. 42, 1922, pp. 205-218; *idem*: The Northward Course of Empire, New York, 1922, Chapter 7.

expedition to Wrangel Island²² to validate through effective occupation the British title assumed to have been acquired through discovery. A party of four, consisting of A. R. Crawford, M. Galle, E. L. Knight and F. W. Maurer, the last two of whom had been on previous expeditions of Stefansson, and an Eskimo seamstress were landed on the island from Nome on September 15, 1921. On the following day the Canadian flag was raised and British possession affirmed. A relief vessel sent from Nome was unable to reach the island in August and September, 1922, because of ice conditions. Finally a relief vessel reached the island the next season, on August 20, 1923, only to find that the whole party except the Eskimo seamstress had perished. She was taken off; but, to continue the occupation, a party of thirteen Alaskan Eskimos in charge of a white Alaskan trapper was left on the island.

The developments of 1921 and 1922 had led to the despatch of several notes by the Soviet Government to the British Government (May 24 and 28, August 21, 1923; British reply of September 3, 1923, and Soviet rejoinder of the same day) in which the raising of the Canadian flag on Wrangel Island was protested as an infringement of Russian rights. On July 20, 1924, the Soviet ice breaker *Krasnyi Oktyabr* (Red October) left Vladivostok, reached Wrangel Island on August 19, raised the Soviet flag there the next day, removed the Alaskan trapper and the thirteen Eskimos as trespassers, confiscating their fur catch, and returned with them to Vladivostok, which port was reached on October 29.²³ The Alaskan trapper died there in January of pneumonia, and the Eskimos (except for two children that died) were finally returned through the offices of the American Red Cross by Japanese steamer from Harbin, Manchuria, to Seattle and thence to their homes in Golovnin Bay, 75 miles east of Nome.²⁴

For two years Wrangel Island was untenanted. In August, 1926, as related above (pp. 49-50), a colony was established consisting of nine Russians (including P. V. Ushakov, Commandant

²² Stefansson, *The Adventure of Wrangel Island*, especially Chapters 6-9 and 15.

²³ B. Davydov: *V tiskakh Ida: Plavanie kanlodki Krasnyi Oktyabr na Ostrov Vrangelya* (In the Grip of the Ice: The Cruise of the Gunboat *Red October* to Wrangel Island), with an introduction on the history of Wrangel Island by E. Shvede, Edit.-Publ. Section of the Navy Dept., Leningrad, 1925. This is the official statement of the Russian case.

²⁴ Stefansson, *The Adventure of Wrangel Island*, Chapter 15.

of the island) and fifty-one Chukchis, with whom connections were maintained in 1927 by airplane and in 1929 by airplane and ship. When the radio weather station was founded in 1929 another house was added to that built in 1926 as well as a storehouse and a bath-house. The provisions landed for the members of the colony, including the seven Russians who replaced the first contingent, are sufficient to last until 1932.

Russian occupation has therefore been continuous for the last four years and seems to be undisputed, inasmuch as the British government has stated that it did not lay claim to the island. This decision was made in 1924 after Stefansson had presented his case before the Canadian Cabinet in Ottawa in the spring of 1923 and the British imperial authorities in the summer of that year. "It appears the Imperial authorities were not disposed to lay claim to the island but, before reaching a decision, submitted the matter to this [Canadian] government. P. C. 1227 of the 17th July, 1924, sets out clearly our position. It says 'The view taken by the Imperial authorities as to the undesirability of laying claim to Wrangel Island is shared by the Government of Canada.'"²⁵

NORWEGIAN ANNEXATION OF JAN MAYEN

Another recent case of establishment of political sovereignty in the Arctic is the annexation by Norway on May 8, 1929, of the island of Jan Mayen (71° N. and 9° W.). This was the culmination of a policy whose trend was certain. In 1921 the island was occupied by the Norwegian Meteorological Institute, a government bureau which has made daily observations of the weather elements since September of that year. And on May 4, 1927, the Minister of State at a session of the Storting had declared that Jan Mayen was considered by Norway as falling within the Norwegian sphere of interest and that the foreign powers concerned had been notified to that effect.

²⁵ Prepared statement by the Minister of the Interior (Charles Stewart), Canadian House of Commons Debates, Vol. 60, No. 84, June 10, 1925, p. 4264.

The Antarctic

PRESENT STATUS OF SOVEREIGNTY

In the Antarctic definite steps as to political sovereignty have been taken as regards two sectors and all the sub-Antarctic islands. (Sovereignty is indicated on the accompanying map of the Antarctic.)

The Sub-Antarctic Islands

Of the islands, the Crozet group and Kerguelen are French, Macquarie is British, and Bouvet and Peter I are Norwegian (see above, p. 21). Each of the two groups, Marion and Prince Edward Islands and Heard and McDonald Islands, are British since France recently renounced her claims to them.²⁶ On the continent itself, Adélie Land, an area bounded by the parallels 66° and 67° S. and the meridians 136° 20' E. and 142° 20' E. of Greenwich, was annexed to France by decree of March 27, 1924.²⁷

The Falkland and Ross Sectors

The two sectors, the Falkland Islands Dependencies (between 80° and 20° W. and the South Pole and the 58th parallel, except between 50° and 20° W., where it extends outward to the 50th parallel) and the Ross Dependency (between 150° W. and 160° E. and the South Pole and the 60th parallel) were declared British respectively by Letters Patent of July 21, 1908, and March 28, 1917, and by Order in Council of July 30, 1923. The delineation of these sectors on a map, as on the present map of the Antarctic, tends to give a wrong impression unless it be again remembered, as in the case of the Arctic (see above, p. 61), that sovereignty holds only for the lands (and the conventional territorial waters)

²⁶ *Renseign. Colon. (Suppl. à l'Afrique Française)*, June 1, 1930, p. 343; *Atlas Colonial Français*, published by *L'Illustration*, Paris, 1929, Pls. 2 and 26 and text pp. 176-177. The first edition (1929) of the map of the Antarctic accompanying the present booklet still shows these islands as claimed by both countries.

In this connection it should be noted that Heard Island was discovered by an American. For the entry of November 25, 1853, reporting the discovery in the hitherto unpublished log of the bark *Oriental*, Boston to Melbourne, Captain John J. Heard, master, see *Geogr. Rev.*, Vol. 20, 1930, p. 683.

²⁷ Gustave Regelsberger: *Les îles Crozet et la terre Adélie, L'Océanie Française*, Vol. 20, 1924, pp. 137-138.

within these limits. By international law, jurisdiction does not apply to the high seas within the two sectors. It was only in the territorial waters and at the shore stations that Britain could control the whalers, and it was in order to free themselves from this control, as already stated (pp. 20-21), that the Norwegians developed the "floating factory," which made it possible to conduct and complete on the high seas all the operations of whaling. The text itself of the Letters Patent and the Order in Council in question makes it clear that jurisdiction only over the lands is claimed. The relevant passages in the three documents follow.

The Letters Patent of July 21, 1908, relating to the Falkland Islands Dependencies read:

Whereas the groups of islands known as South Georgia, the South Orkneys, the South Shetlands, and the Sandwich Islands, and the territory known as Graham's Land, situated in the South Atlantic Ocean to the south of the fiftieth parallel of south latitude, and lying between the twentieth and the eightieth degrees of west longitude, are part of Our Dominions, and it is expedient that provision should be made for their government as Dependencies of Our Colony of the Falkland Islands:

1. Now We do hereby declare that from and after the publication of these Our Letters Patent in the Government Gazette of Our Colony of the Falkland Islands the said groups of islands known as South Georgia, the South Orkneys, the South Shetlands, and the Sandwich Islands, and the said territory of Graham's Land shall become Dependencies of Our said Colony of the Falkland Islands.²⁸

In the Letters Patent of March 28, 1917, the extent of the same dependencies is defined as follows:

Whereas doubts have arisen as to the limits of the groups of islands known as South Georgia, the South Orkneys, the South Shetlands, and the Sandwich Islands, and the territory of Graham Land otherwise known as Graham's Land; and whereas it is expedient that provision should be made for the government, not only of these islands and territory but also of certain other Our islands and territories adjacent thereto as Dependencies of Our Colony of the Falkland Islands:

1. Now We do hereby declare that from and after the publication of these Our Letters Patent in the Government Gazette of Our Colony of the Falkland Islands, the Dependencies of Our said Colony shall

²⁸ Statutory Rules and Orders . . . Issued in the Year 1908, published by His Majesty's Stationery Office, London, 1909, p. 1042.

be deemed to include and to have included all islands and territories whatsoever between the 20th degree of west longitude and the 50th degree of west longitude which are situated south of the 50th parallel of south latitude; and all islands and territories whatsoever between the 50th degree of west longitude and the 80th degree of west longitude which are situated south of the 58th parallel of south latitude.²⁹

The Order in Council of July 30, 1923, creating the Ross Dependency reads:

And whereas the coasts of the Ross Sea, with the islands and territories adjacent thereto, between the 160th degree of east longitude and the 150th degree of west longitude, which are situated south of the 60th degree of south latitude, are a British settlement within the meaning of the said Act [British Settlements Act of 1887]:

And whereas it is expedient that provision should be made for the government thereof:

Now, therefore, His Majesty, by virtue and in exercise of the powers by the said Act, or otherwise, in His Majesty vested, is pleased, by and with the advice of His Privy Council, to order, and it is hereby ordered, as follows:—

1. From and after the publication of this Order in the Government Gazette of the Dominion of New Zealand that part of His Majesty's Dominions in the Antarctic Seas,³⁰ which comprises all the islands and territories between the 160th degree of east longitude and the 150th degree of west longitude which are situated south of the 60th degree of south latitude shall be named the Ross Dependency.³¹

Non-Acquiescence in Those Sectors

British sovereignty over these two sectors has not, it appears, been officially recognized by either Norway or the United States.

²⁹ Statutory Rules and Orders. . . . Issued in the Year 1917, London, 1918, pp. 1135-1136.

³⁰ The possibility of misunderstanding the extent of the sovereignty claimed is evidenced by a paper by H. T. Ferrar (The History of Ross Dependency, *New Zealand Journ. of Sci. and Technol.*, Vol. 6, 1923, pp. 205-207) in which, perhaps because of this phrase, he says (p. 207) that "The dependency is defined as all the territory *and seas* to the south of latitude 60° South, which lies between longitudes 160° east and 150° west." Another case of misunderstanding seems to occur in the chapter on Territorial Rights in J. Gordon Hayes's "Antarctica: A Treatise on the Southern Continent", London, 1928, where (p. 360) the Letters Patent of March 28, 1917, are apparently construed to mean that the high seas within the boundaries of the Falkland Islands Dependencies are included under British jurisdiction. The discussion in this work of this and other points relating to the political sovereignty of the two sectors is based on a secondary source and not on the full text of the relevant passages of the documents themselves, as given above.

³¹ Statutory Rules and Orders . . . Issued in the Year 1923, London, 1924, pp. 712-713.

The interest of the United States concerns the Falkland sector and is due to the discovery in 1821 by Captain Nathaniel B. Palmer of Stonington, Conn., of what was until Wilkins' flight of 1928 thought to be the mainland of "Graham Land" and of the islands along this coast that now bear Palmer's name.³² Norway's interest is in those parts of the Ross Dependency visited on Amundsen's South Pole expedition of 1911-1912. The Norwegian Government's position with regard to these areas is indicated in a note of April 15, 1929, communicated by the Norwegian Minister in Washington to the Secretary of State of the United States.³³

. . . In any case, the Norwegian Government assumes that possible claims of this nature [claims by Byrd of territory for the United States] do not comprise any part of the territory immediately circumjacent to the South Pole, which, as will be known, was taken possession of in the name of the King of Norway by Captain Roald Amundsen in December, 1911, under the name of Haakon VII's Plateau, nor to comprise the territories on both sides of Captain Amundsen's route to the South Pole south of Edward VII's Land and including, *inter alia*, Queen Maud's Range.

My Government has instructed me to add that while it is not its intention at the present time to claim sovereignty to the territories referred to above, it considers that the said discovery and annexation constitute a valid basis for a claim of priority to acquire such territories whenever the requirements of international law as to effective occupation of a new territory shall have been fulfilled.

Furthermore, as far as the sovereignty to Edward VII's Land in the Antarctic regions is concerned, the Norwegian Government is of the opinion that considerable weight should be laid upon the fact that the said land or region was explored, mapped, and occupied in the name of Norway by Mr. Prestrud and his companions, who, previous to anyone else, in 1911 visited the region referred to on a sledging expedition from the Bay of Whales.

Territorial Claims Outside the Sectors

Outside of the two sectors and the sub-Antarctic islands definite claims of sovereignty have been made with regard to certain areas. The British claim to the various segments of the margin of the

³² E. S. Balch: Stonington Antarctic Explorers, *Bull. Amer. Geogr. Soc.*, Vol. 41, 1909, pp. 473-492; *idem*: Antarctica, Philadelphia, 1902, pp. 85-95.

³³ Quoted by the Norwegian Consul General in New York, Mr. W. de M. Morgenstierne, at the Institute of Politics, Williamstown, Mass., Aug. 5, 1930 (as reported in the minutes; see also *New York Times*, Aug. 6, 1930).

Antarctic Continent explored by British expeditions between 160° E. and 20° E. in the Australian and African Quadrants is stated in the British note of November 17, 1928, to the State Department, referred to immediately below, and the areas in question are there specifically named. The claim to Enderby Land has of course been reinforced by Mawson's act on Proclamation Island this year (see above, p. 32), and the discovery of MacRobertson Land and the confirmation of Kemp Land (p. 31) increase the range of British claims in this area. Riiser-Larsen's raising of the Norwegian flag on the northwest coast of Enderby Land (p. 23) and his discovery of Queen Maud Land (p. 25) and Crown Princess Martha Land (p. 26) all afford new bases for Norwegian claims.

UNITED STATES RIGHTS

The question of United States rights in the Antarctic has been raised by Byrd's expedition, inasmuch as he has claimed Marie Byrd Land for the United States (see above, p. 12). The fact that he has discovered a stretch of coast outside the Ross Dependency from which Marie Byrd Land can be reached without crossing foreign territory, has, as was pointed out above (p. 16), strengthened the American claim.

At about the time that Byrd's expedition was sailing from New Zealand the British Ambassador to the United States delivered to the State Department a note from the British Government dated November 17, 1928. It stated that His Majesty's Government in various dominions of the Empire had noted that an American scientific expedition to the Antarctic under Commander Byrd was being carried out and remarked that these Dominions had followed the progress of the expedition with special interest because of the concern which they themselves had in the areas where, it was understood, Commander Byrd would primarily explore. The note recalled that at the Imperial Conference held in London, 1926, it was agreed that to certain areas in the Antarctic a British title already exists by virtue of discovery. These areas include (see the Antarctic map) that portion of Coats Land lying outside the Falkland Islands Dependencies, Enderby Land, Kemp Land, Queen Mary Land, Wilkes Land (in Mawson's restricted sense: between about 130°

and 136° W.), King George V Land, and Oates Land. (These areas, it will be noted, are all outside either of the two sectors.) The British note closed with an offer to instruct the appropriate British authorities to afford Commander Byrd every assistance, if desired, while his expedition is in the Ross Dependency or the Falkland Islands Dependencies.³⁴

The State Department's reply, dated November 15, 1929, was transmitted through the American Chargé d'Affaires at London to the British Foreign Office. The delay of nearly a year in responding is partly due to the fact that the State Department desired the opportunity to make a thorough study of all the circumstances and considerations. Although the text of the reply is not available it is understood that it does not acquiesce in the British claims but leaves the issue open for further discussion. It assumes that the reference to British title in the territories listed was given merely as a matter of information for the State Department. Consequently, it was added, the Department could make "no comment at this time."³⁵

Aside from Byrd's recent discoveries any claim the United States might advance would probably be based on the work of the United States Exploring Expedition under Lieutenant Charles Wilkes in 1840. Wilkes believed he had outlined the Antarctic Continent fringing the Antarctic Circle through about 65° of longitude (95°-160° E.), but later expeditions, especially those of Scott and Mawson, have shown at both ends of this arc that some of his landfalls do not exist. It seems probable that he sometimes mistook for land the northern edge of the shelf ice and the solid pack with icebergs embedded in it. Nevertheless it is a fact that he first outlined in their continuity, and recognized as such, the phenomena of a continental margin for a distance of 1800 miles.

The question of the claims of the United States to Wilkes Land (in the broader sense of the segment of the continental margin discovered by Wilkes) has engaged the attention of the State Department on a previous occasion. In 1924 the then Secretary of State held:

It is the opinion of the Department that the discovery of lands unknown to civilization, even when coupled with a formal taking of possession,

³⁴ *New York Times*, Nov. 29, 1929.

³⁵ *New York Times*, March 16, 1930.

does not support a valid claim to sovereignty unless the discovery is followed by an actual settlement of the discovered country. In the absence of an act of Congress assertative in a domestic sense of dominion over Wilkes Land this Department would be reluctant to declare that the United States possessed a right of sovereignty over that territory.³⁶

The present attitude of the State Department evidently differs from this. The note of November 15, 1929, just referred to, would appear to indicate this; likewise the later developments relating to Byrd's discoveries outside of the Ross Dependency. For when a report³⁷ reached the United States from New Zealand misquoting³⁸ Admiral Byrd to the effect that he had said that he had no intention of claiming for the United States the new lands he had discovered and that he had found them for the world as much as for his own country, the Acting Secretary of State announced³⁹ that such a statement even by the discoverer himself, if correctly reported, would have no binding force upon the Government of the United States. At least one reflection of popular sentiment in the matter is afforded by the resolution introduced in the Senate on July 1, 1930, by Senator M. E. Tydings of Maryland, which was ordered laid on the table, authorizing and directing the President "to lay claim to all areas in the Antarctic which have been discovered by American citizens."⁴⁰

The various intimations of the recent attitude of the State Department in this question would seem to indicate that the changed conditions brought about by man's increasing conquest of nature are being taken into consideration. This position, and not the attitude which characterized the purchase of Alaska as "Seward's folly," would seem to be the wise one, at least if the interests of the United States are to be safeguarded. Private initiative here again is quick to sense the new possibilities: on August 30, 1930, the 6000-ton whaler *Frango* of the newly organized American Whaling Company sailed from New York for the Antarctic under the American flag.⁴¹ She is equipped for pelagic whaling.

³⁶ *New York Times*, June 30, 1929.

³⁷ *ibid.*, March 14, 1930.

³⁸ *ibid.*, March 25, 1930.

³⁹ *ibid.*, March 16, 1930.

⁴⁰ 71st Congr., 2nd Sess., S. Res. 310, and *New York Times*, July 1, 1930.

⁴¹ *New York Times*, Aug. 30, Sept. 1, 1930.

ARGENTINE ANTARCTIC INTERESTS

The opening up of the question of sovereignty has affected one other country that has interests in the Antarctic, Argentina. Argentina has never renounced her claim to the Falkland Islands, which, she contends, were taken from her forcibly in 1833 after one year's possession.⁴² Argentina maintains a wireless and a meteorological station on the South Orkneys and claims the islands on that ground.

General

CONSIDERATION OF GEOGRAPHICAL FACTORS IN THE SETTLEMENT
OF POLITICAL SOVEREIGNTY

In the discussion of political sovereignty in the Polar Regions in the present booklet it has been the chief aim to record the developments of recent years. The principles of international law (at least in their strictly legal aspects) have not been dealt with because they are regarded as outside of the province of the geographer. The reader desiring information on this score is referred to a standard manual on the subject.⁴³ However, in any consideration of these questions which aims to achieve an equitable result, the geographical factors must be taken into account.

This is especially important because physical conditions in the Polar Regions differ radically from those in temperate lands, where the principles of international law have in the main been formulated. The outstanding differentiating characteristic of the Arctic and Antarctic is, of course, the set of special conditions created by the existence and dominating influence of the ice. Too often our thoughts are guided by the common representation of our maps, in which the body of water north of America and Eurasia appears as open sea. The real state of affairs is shown only on the exceptional map, namely that, from the point of view of ship navigation, a solid mass extends from the pole right down to the northern coasts of these continents. Only in summer, and then not always throughout the whole circumference, does this solid mass recede slightly

⁴² On the Argentine claim to the Falklands see Julius Goebel, Jr.: *The Struggle for the Falkland Islands: A Study in Legal and Diplomatic History*, New Haven, 1927, Chapter 9 and Conclusion.

⁴³ W. E. Hall: *A Treatise on International Law*, 8th edition, edited by A. Pearce Higgins, Oxford, 1924. Some of the works cited in footnote 1, pp. 61-62, also deal with this topic.

northwards, leaving a grudgingly narrow lane of open water along the coast and a few larger embayments at favored localities, such as Barents Sea or north of Bering Strait. If these facts had been known there would have been no seeking for the Northeast and Northwest Passages.

Now that these facts are known, the limitations that they impose on surface ship navigation are apparent. But in the meantime modern technique has provided man with two new vehicles, air craft and under-sea craft. These create new relationships to the physical conditions. On the one hand, the airship or airplane, by being able to land on it, transforms the floating pack ice into what in effect is solid ground, thereby raising the question as to whether, in the Arctic sectors previously discussed, a country's jurisdiction might be extended to areas beyond the traditional "territorial waters." On the other hand, the submarine, by being able to navigate under the ice, as the Germans did during the World War in the White Sea⁴⁴ and as Wilkins proposes to do on his forthcoming expedition of 1931 across the Arctic Sea, restores, so to speak, to an ice-covered sea the function and attributes of open water.

In the Antarctic the great sheets of shelf ice, attached to the land but floating on the sea, present a special territorial problem. Where does the "land" end and where the sea begin? This is a very real problem, as ship navigation is possible right to the border of the foremost example of this type of ice, the vast Ross Shelf Ice, as Amundsen, Byrd, and others have shown. From the nautical point of view the edge of the shelf ice *is* the border between "land" and sea. But should this interpretation prevail in the settlement of the larger questions of territorial jurisdiction?

It is such problems as these that confront those concerned with the formulation of international law with regard to the Polar Regions. It has here been possible to suggest only a few, but, it is hoped, a sufficient number of cases has been cited to show that the question of political sovereignty in the Arctic and Antarctic requires, for an equitable solution, the consideration of factors that are different from those that obtain in other parts of the world.

⁴⁴ S. A. Buturlin: *Chto takoe "Sever", kto tam zhivet i budushchĕe mirovoe znachenie ego* (What the North is, who lives there, and what its future world importance is), *Sovetskii Sever*, [No. 1], Moscow, 1929, pp. 5-65; reference on p. 63.

THE TWO POLAR MAPS AND SOME FEATURES THEY ILLUSTRATE

THE two maps accompanying this booklet are physical maps, i.e. they primarily represent relief. The Physical Map of the Arctic shows the relief of both the land and the sea bottom, with emphasis on the former; the Bathymetric Map of the Antarctic, as its title implies, shows the relief of the sea bottom. The areas of known land in the Antarctic (indicated by the full buff color on that map) are too small to lend themselves to the detailed representation of relief employed on the map of the Arctic; what is known of elevations is represented by means of generalized contours with a vertical interval of 1000 meters.

THE PHYSICAL MAP OF THE ARCTIC

The map of the Arctic consists of a circular main map of the area from the North Pole to latitude 58° N. on a scale of 1:20,000,000, or about 315 miles to the inch, and inset maps, on larger scales, of the Smith Sound-Robeson Channel region ("the American route to the Pole"), southern, northernmost, and northeastern Greenland, Jan Mayen, Bear Island, the Ice Fiord region of Spitsbergen, the Spitsbergen archipelago, Franz Josef Land, Novaya Zemlya, and Bering Strait. Relief of the land is shown by layer coloring in five tints combined with hachures, and the tundra is distinguished by shading; submarine relief is shown by layer coloring in five tints. Inland ice, glaciers, drift ice and its farthest limits, and ocean currents are also indicated. Within the land-encircled Arctic Basin the belts of explored territory are shown in color, the remaining unknown areas being left in white (they are shown in gray on Fig. 6 for emphasis); and the leading routes of exploration by ship and sledge and by air are indicated, with name and date.

The map is an English version, prepared by the American Geographical Society, of the Arctic map appearing in the eighth edition of Andree's Handatlas (1924), one of the two leading German reference atlases. The preparation of the English version consisted not merely of a translation of the names but of a thorough

revision of the map. The distinction between explored and unexplored areas in the Arctic Basin is a new feature that was added. The next German edition of the map, in the ninth edition of the atlas, will incorporate the results of the American Geographical Society's revision and this new feature also.

THE BATHYMETRIC MAP OF THE ANTARCTIC

As the map of the Antarctic includes the southern parts of South America, Africa, and Australia it embraces practically all of the Atlantic, Indian, and Pacific Oceans within the Southern Tropic. Bathymetry is shown by a large number of soundings and by means of layer coloring in ten tints, buff for the continental shelf and nine shades of blue for the oceanic depths. As the map is on the same scale, viz. 1:20,000,000, it is directly comparable with the map of the Arctic. It is also on the same scale as the revised bathymetric map of the Arctic Basin by the late Dr. Nansen, published in 1928 in the Society's *Special Publication No. 7* ("Problems of Polar Research"), and its method of representing the depths of the ocean is the same. Nansen's map and the bathymetric map of the Antarctic, therefore, constitute companion tools in the study of polar oceanography.

The map of the Antarctic was compiled and drafted by Mr. W. A. Briesemeister of the staff of the American Geographical Society under the direction of the writer.

THE ARCTIC AND ANTARCTIC AS NATURAL REGIONS

When we speak of "the Arctic" or "the Antarctic" most of us would be at a loss to say how far towards the equator from each Pole we understood each of these regions to extend. To say that they are bounded by the Arctic and Antarctic Circles may define them correctly from the astronomical standpoint. But although the polar caps thus defined belong to the fundamental system of mathematical zones related to climatic phenomena, the actual climatic zones in many places depart widely from these regular belts owing to the irregular influences that shape them—irregular because of the unequal distribution of land and water. Thus the edges of the

Arctic and the Antarctic, like those of the climatic belts between, are lobate in outline, projecting outward in one place and receding in another.

But how determine where these fluctuating lines lie? Of course in nature there is, as a rule, no hard and fast line where the Polar Regions begin and the temperate belts end. Otherwise delimiting the Arctic and the Antarctic would be a question of determining in the field the position of a line physically visible. A concrete line of this type is the polar limit of trees, and possibly no single element expresses so well the change from temperate to polar conditions. But even this limit, as is generally the case with natural phenomena, is not abrupt; it is, rather, a ragged fringe in which forest alternates with tundra and patches or fingers of the one are found within the territory of the other.

Nevertheless the difference between temperate and polar regions is a very real thing, however gradual the transition. Central Alaska with its cereal cultivation centering around Fairbanks is certainly a different region from the barren plain stretching northwards from the Brooks Range to the coast at Point Barrow, and the Belcher Islands of Hudson Bay, winter hunting grounds of Eskimos, represent a habitat fundamentally different from the section of Denmark about Copenhagen, although both are in the same latitude. It must, therefore, be possible in some way to determine where the boundary belt lies between so divergent areas. This has been attempted by the late Otto Nordenskjöld, an eminent Swedish geographer and polar explorer specializing in polar research.¹ Basing his study on the work of Vahl, a Danish plant geographer, on the relationship between climate and vegetation, he suggests a simple formula by means of which it is possible to determine whether or not a given place falls within the Polar Regions. This formula, which is modified from Vahl, reads $w + 0.1c = 9^\circ$, where w is the mean temperature (in degrees Centigrade) of the warmest month at a given place, c that of the coldest month, and 9° (C.) and the coefficient of c are empirically determined constants. This means that if for a given place $w + 0.1c$ is greater than 9° C. that place should be assigned to the temperate belt,

¹ The Geography of the Polar Regions, *Amer. Geogr. Soc. Special Publ. No. 8*, 1928, pp. 72-86.

if less than $9^{\circ}\text{C}.$, to the Polar Regions. Applying this formula to the temperature records of available stations that come into consideration (and except for the European Arctic they are generally widely scattered and the records are short, especially in the Antarctic), Nordenskjöld prepared the accompanying two maps (Figs.



FIG. 8

FIGS. 8-9—Maps of the natural provinces of the Polar Regions, by Otto Nordenskjöld. Drawn to the same scale, 1:83,700,000, both maps are directly comparable as regards space and size relations. The Antarctic map necessarily covers a greater area because of the greater extent of equivalent phenomena in the Antarctic than in the Arctic.

The outer limit of the Polar Regions is laid down according to a modification of Vahl's formula (see the text) expressing relationship between climate and vegetation. Within this limit the land in the Polar Regions is divided, mainly on the basis of the mean temperature of the warmest month, into three major provinces: I, Outer Polar Belt; II, High-Polar Belt; III, Antarctic Province. The Arctic representative of II, the High-Arctic Belt, is subdivided into: A, the

8 and 9) on which the outer limits of the Arctic and Antarctic are shown by a heavy line. The wavy nature of this line is especially

evident in the case of the Arctic, where it reflects the well-known northward trend of warmer climatic influences on the western continental margins, as in Norway and our North Pacific coast, with a corresponding southward thrust of polar conditions on the eastern margins, as in Labrador and northeastern Siberia. In the Antarctic,

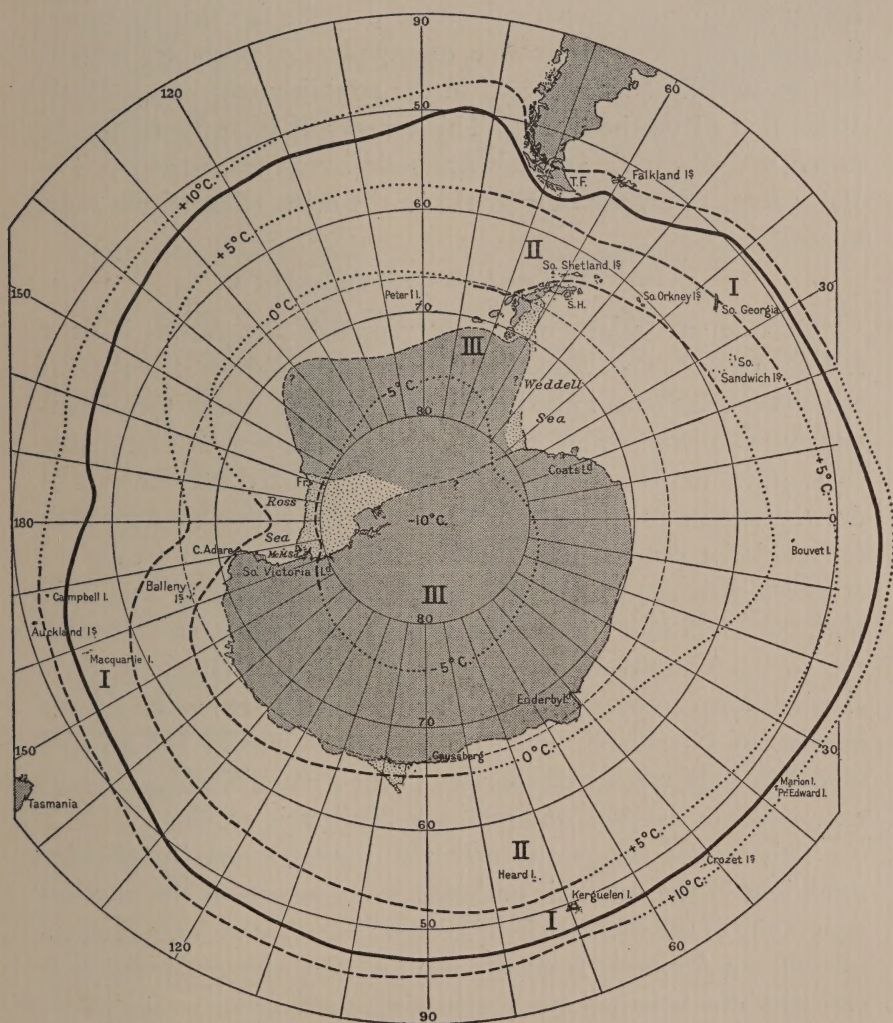


FIG. 9

greater part of the American Arctic Archipelago; B, the northern part of the border of Greenland; C, the North Atlantic polar islands; D, the outermost fringe of the Arctic coast of Siberia and its offshore islands. Types I and II are not represented in the Antarctic except for a number of isolated islands; type III, except for the inland ice of Greenland, is not represented in the Arctic. Types II and III together may be considered to constitute the inner Polar Regions proper.

The isotherms shown indicate the mean temperature of the warmest month in C°; their position is of course approximate only.

where water predominates over land, oceanic influences tend to smooth out the line.

In addition to the outer limits of the Polar Regions, these maps show the subregions into which the Arctic and Antarctic may be divided, as enumerated in the caption. We need not go into this matter here further than to call attention to the fact that the transitional nature, referred to above, of any physical boundary is taken into account by Nordenksjöld in the establishment of his Outer Polar Belt (I on the maps). This consists of what might also be called the sub-Arctic and sub-Antarctic zones, respectively. The Polar Regions proper thus would be the areas lying within these zones.

GREATER AREA OF THE ANTARCTIC

Because our atlases generally represent the Antarctic on a smaller scale than the Arctic our notions of the comparative sizes of these two areas tend to be inaccurate. For this reason the accompanying two maps (Figs. 8 and 9) may not appear at first glance to be drawn to the same scale. When it is realized that they are so drawn, it becomes apparent how much larger is the Antarctic than the Arctic, i.e. polar conditions dominate a much greater area at the southern than at the northern extremity of the earth. Not only that, but conditions are intensified in the south as compared with the north. The two milder climatic provinces of Nordenksjöld's classification occupy the whole Arctic with the exception of the interior of Greenland, whereas these types, except for isolated oceanic islands, are not represented in the Antarctic, which belongs completely to the third and most severe climatic province.

This fact of the greater extent and greater severity of polar conditions in the Antarctic underlies many aspects of the physical geography of the southern hemisphere. Together with the remoteness of the Antarctic from the main centers of population these characteristics have had much to do with retarding Antarctic exploration and making it especially hazardous.

PREVIOUS BATHYMETRIC MAPS OF CIRCUM-ANTARCTIC WATERS

In contrast to the Arctic, which is primarily a deep-sea basin surrounded by land, the Antarctic consists of a high continent en-

circled by a ring of waters. Although large areas of the Arctic Sea are still unknown and unplumbed, its general characteristics and the probable configuration of its basin have repeatedly been discussed.² But the bathymetry of the circum-Antarctic waters has received less attention, and it may therefore not be amiss to point out the larger features of submarine relief on the basis of the present Bathymetric Map of the Antarctic, which, so far as known, is the second attempt only to represent the depths of the circum-Antarctic waters on a relatively large scale and on a polar projection.³

INAPPROPRIATENESS OF TERM "ANTARCTIC OCEAN"

But before discussing the relief features it may be advisable to point out that, as regards the waters themselves, the present map follows the best usage of modern oceanography, according to which the Atlantic, Pacific, and Indian Oceans are considered to extend southward right down to the Antarctic Continent, between the meridians respectively of the southernmost projections of Africa, South America, and Australia. The earlier concepts of a Southern Ocean or an Antarctic Ocean are possibly justifiable from a nautical point of view or to express the homogeneity of conditions at the sur-

² e.g. by Fridtjof Nansen: *The Oceanographic Problems of the Still Unknown Arctic Regions*, in "Problems of Polar Research," *Amer. Geogr. Soc. Special Publ. No. 7*, New York, 1928, pp. 3-14, accompanied by the bathymetric map mentioned above on p. 80.

³ The previous attempt is Gerhard Schott's map in 1:25,000,000 representing the status of knowledge in 1905 and accompanied by text entitled: *Die Bodenformen und Bodentemperaturen des Südlichen Eismeeres*, *Petermanns Mitt.*, Vol. 51, 1905, pp. 241-247.

The standard bathymetric maps of the oceans (Groll's of the Atlantic, Pacific, and Indian Oceans, each in 1:40,000,000, *Veröffentl. Inst. für Meereskunde*, Series A, No. 2, Berlin, 1912—also as wall maps in 1:20,000,000—and the Prince of Monaco's world map on Mercator's projection in 16 sheets, equatorial scale 1:10,000,000, with 8 polar quadrants on a polar projection in 1:3,000,000, 2nd edit., Paris, 1912-1927) indeed include Antarctic waters but do not show them connectedly.

Other bathymetric maps that come into consideration are Schott's map of the Atlantic, 1:30,000,000, accompanying his "Geographie des Atlantischen Ozeans," 2nd edit., Hamburg, 1926; the same author's map of the Atlantic and Indian Oceans together, 1:30,000,000 (*Wiss. Ergebn. der Deutschen Tiefseee Exped. auf der Valdivia, 1898-1899*, atlas, Jena, 1902, Pl. 3; Drygalski's map of the southwestern Indian Ocean, equatorial scale 1:20,000,000 (*Deutsche Südpolar Exped. 1901-1903*, Vol. 7, No. 5, Berlin, 1926, Pl. 5), Bruce's map of the South Atlantic and Weddell Sea, 1:14,000,000 (*Scottish Geogr. Mag.*, Vol. 21, 1905), and Norden-skjöld's map of the same region, 1:5,000,000 (*Wiss. Ergeb. n. der Schwed. Südpolarexped.*, 1901-1903, Vol. 1, No. 2, Stockholm, 1917, Pl. 2). Murray's maps of the three oceans, 1:45,000,000, accompanying the *Challenger* reports (Summary of Results, Part I, London, 1895, Charts IA, IB, IC) are out of date. The bathymetric maps of the three oceans by George Philip & Sons (Harmsworth Atlas, London, 1907, Pls. 11-12, 101-102, 195-196, and Philips' Mercantile Marine Atlas, 12th edit., London, 1926, Pls. 34, 37, 38) are useful.

face throughout the circumpolar ring of waters.⁴ However, these concepts do not take into account the physical unity of the great ocean basins, as established by recent research.⁵ This indicates that there is an interchange of water from one end of a basin to the other, there usually being three layers: the cold bottom water, which originates at the base of the Antarctic Continent and flows northward along the bottom; the intermediate or tropical water, which develops in the tropics and flows southward in middle depths toward the Antarctic Continent; and the polar water, which begins near the surface at the edge of the Antarctic Continent and then gradually sinks as it flows northward to the equator and even some distance beyond.

SUBMARINE RELIEF OF SOUTHERNMOST ATLANTIC, PACIFIC, AND INDIAN OCEANS

Turning now to the features of submarine relief, viewed broadly it would seem as if the Antarctic Continent were surrounded some

⁴ The element imparting a homogeneous character to this ring of waters is, of course, the ice. To gain a proper picture of its extent a map is needed showing, say, the average position of the pack ice and the average northern limit of icebergs during the southern summer. A contributory map of this type is the invaluable Ice Chart of the Southern Hemisphere [within the 30th parallel], 1:22,000,000, originally prepared by Staff Commander F. J. Evans and Captain G. F. McDougal, R.N., and published by the British Admiralty in 1866 as Chart No. 1241. It has appeared in an edition as late as 1910, incorporating the material from Cook, 1772-1775, down to Shackleton, 1908-1909, but there is need of a compilation more recent and more comprehensive as to non-British expeditions. On Chart No. 1241 ten different symbols for icebergs are used, one for each month of the year except for the three winter months, for which there is a single symbol. As hundreds of icebergs are plotted, this makes it possible to follow well the seasonal advance and retreat in any given sector.

Successors of this map, although not so comprehensive by far, are the maps of the same area, one in 1:40,000,000 showing conditions during the spring from 1902 to 1917 (on back of Monthly Meteorological Chart of East Indian Seas for October, 1917, Meteorological Office, London, Aug. 30, 1917), and the other in 1:65,000,000 showing conditions during the winter from 1902 to 1928 (*Marine Observer*, Vol. 6, 1929, plate facing p. 166, Meteorol. Committee, Air Ministry, London).

As ice is the outstanding distinctive physical element of the polar seas, it may be appropriate here to call attention to its cartographic representation in the Arctic also. The standard work in this field is the series of maps showing conditions in April, May, June, July, and August of each year published in the annual reports entitled "The State of the Ice in the Arctic Seas" by the Danish Meteorological Institute, Copenhagen, in its *Nautical-Meteorological Annual* since 1900 (maps of average, maximum, and minimum monthly limits of ice accompany a summary based on the observations of 1898-1913 that appears in the 1916 *Annual*). A valuable feature of this series is the representation of different types of ice by means of different symbols (in red). The maps in the Russian series "The State of the Ice in the Seas of the U.S.S.R." referred to above on pp. 49-50 in footnotes 54, 55a, and 56 likewise differentiate among ice types, in this case by means of ingenious black-and-white symbols (the maps in the Samoilovitch publications referred to in footnote 80, p. 55, and footnote 9, p. 64, are of the same nature but with explanations in German). The following types of ice are distinguished in these two series: young ice and brash, open drift ice (small pieces), dense drift ice (large pieces), flat ice fields, hummocky ice fields, pack ice, land-fast ice, icebergs.

⁵ Erich von Drygalski: The Oceanographical Problems of the Antarctic, in "Problems of Polar Research," *Amer. Geogr. Soc. Special Publ. No. 7*, New York, 1928, pp. 261-278; Georg Wüst: Der Ursprung der atlantischen Tiefenwässer, Sonderband zur Hundertjahrfeier der Gesellschaft für Erdkunde zu Berlin, Berlin, 1928, pp. 506-534, with cross sections.

distance offshore by three vast depressions⁶ separated by three axes of crustal uplift. Following Schott's and Drygalski's maps (see footnote 3) the depressions are termed on our map the Pacific Antarctic Basin, the Atlantic-Indian Antarctic Basin, and the Indian Antarctic Basin⁷ in accordance with the ocean or oceans at whose southernmost extremity they lie. The first and the second are separated by the Antarctic Archipelago and its offshoot, and the second and third by the Kerguelen-Gaussberg Ridge, which extends from a platform crowned by Kerguelen and Heard Islands south-eastward to the Gaussberg on the continent. The third and first depressions are separated by a region of uplift, left nameless on the map, which may consist of two axes, one extending from Tasmania via the Mill Bank⁸ and some shallower soundings to the Balleny Islands and the continent, the other reaching across from New Zealand via Auckland and Macquarie Islands to coalesce with the first axis.

In general these depressions seem bounded on their outer, or northern, sides by rises that separate them from the deeper waters beyond. Thus the Atlantic-Indian Rise (the southern continuation of the median rise that divides the whole Atlantic longitudinally from north to south), with its emergent peak Bouvet Island, and the Crozet Ridge intervene between the Atlantic-Indian Antarctic

⁶ A speculation may be permitted as to a possible genetic relationship between this circum-polar moat and the Antarctic Continent. Two lines of approach may be suggested: (1) a closer study of the structure and physiography as facts become known through later exploration and (2) further gravity measurements which might show a distribution of densities conforming appropriately to the consequences of the theory set up by Chamberlin respecting the origin of some of the grosser terrestrial features through evolution of an earth-bolt of solar origin (T. C. Chamberlin: *The Two Solar Families: The Sun's Children*, Chicago, 1928, Chapters 18, 19, 20). This line of thought is sketched by Isaiah Bowman in a paper entitled "Antarctica" (*Proc. Amer. Philos. Soc.*, Vol. 69, 1930, No. 2, pp. 19-43) as follows: "Reflecting on the great contrast between the north and south polar regions, the one a hollow, the other a hump, Chamberlin speculated on the possibility that we have in these and other lineaments of our earth actual 'birth marks', as we may call them. He saw in the assembly of materials of which the earth is composed traces of the original bolt of matter shot out from the sun to make the infant earth. The core was built up of heavier material at the end originally toward the sun and of lighter material at the end away from the sun. The heavier Antarctic end was of course still further modified in the course of time while the lighter materials eventually were shaped into the ring of land that lies chiefly in the northern hemisphere."

⁷ On the internationally accepted terminology for submarine relief see: A. Supan: Terminologie der wichtigsten unterseeischen Bodenformen, *Petermanns Mitt.*, Vol. 49, 1903, pp. 151-152; A. P. Niblack: Terminology of Submarine Relief, *Hydrogr. Rev.*, Vol. 5, No. 2, November, 1928, pp. 9-23, Internatl. Hydrogr. Bureau, Monaco.

⁸ This is the "Mill Rise" of the reports of the Australasian Antarctic Expedition of 1911-1914, which discovered it. As this feature, however, is not of the order of magnitude for which the term *rise* is prescribed in the international agreements cited in the preceding footnote, it has, on the present map, been given the generic term appropriate to its size. In this connection it may also be observed that these international agreements discourage the selection of personal names to designate the forms of submarine relief—a practice fostered by the *Challenger* reports—and advocate instead the use of names derived from related physical features.

Basin and the deeper waters of the Cape Basin and the depression south of Madagascar. The Indian Antarctic Basin is separated by lesser depths from the deep South Australian Basin that parallels the south coast of Australia close inshore. Even the less sharply defined Pacific Antarctic Basin seems divided from the Central Pacific by a belt of higher ground, forming the southwestern continuation of the Easter Rise (so named after Easter Island), which seems to connect with the shallower areas off the entrance to Ross Sea.

A special individual feature is the deep trench, 8100 meters deep, on the eastern side of the South Sandwich Islands. Its resemblance to the trenches on the outward, convex side of other island arcs, such as the Aleutians, the Kuriles, and to a certain extent the Lesser Antilles, may be due to similarity of structural origin.

Among minor features attention may be called to three banks on the edge of the continental shelf separated from the mainland coast by a moat, as Mawson has termed this trough of deeper water in the case of one.⁹ These banks lie off Queen Mary Land (95° E.), Adélie and King George V Lands (145° E.), and at the entrance to Ross Sea. Each is backed by a large area of shelf ice or by glacier tongues. Griffith Taylor has suggested¹⁰ that they may represent vast terminal moraines deposited when the continental ice sheet extended from 100 to 300 miles farther northward.

The features of submarine relief outlined above are necessarily sketched only in a broad and general way, inasmuch as the existing soundings are too few to define even major features with reasonable accuracy. The difference between a fairly well and an insufficiently sounded area is readily evident by comparing the Atlantic with the Pacific portion of the map. The much greater detail in the

⁹ Sir Douglas Mawson: *The Home of the Blizzard*, 2 vols., London, [1915]; reference in Vol. 2, diagram on p. 267.

¹⁰ Griffith Taylor: *Antarctic Adventure and Research*, New York, 1930, pp. 158-161. Taylor proposes for these banks respectively the names of Davis Bank (after Captain J. K. Davis; see above, p. 29), Mawson Bank, and Pennell Bank (after Commander Harry Pennell, R. N., who commanded the *Terra Nova* on her Antarctic voyages and died while in charge of his ship early in the World War). As this suggestion was published later than the first (1929) edition of our bathymetric map of the Antarctic, it was not possible there to take it into account. It may be noted that, for what may be the eastern end of the Davis Bank, Mawson, basing his proposal on soundings of 710 and 870 fathoms (1299 and 1591 meters) in about $63\frac{1}{4}^{\circ}$ S. and 102° E. as compared with deeper water farther landward (1080 fathoms or 1975 meters) in about the same longitude, suggests the name Bruce Rise (*Home of the Blizzard*, Vol. 2, p. 269 and diagram on p. 295).

former is mainly due to the work of the German Atlantic Expedition of 1925-1927 on the *Meteor*, during which many hundreds of soundings were made by the new echo method.¹¹ One of the great needs of oceanography is to have the other two oceans, especially the Pacific, covered with an equally dense network of soundings and hydrological observations.

¹¹ The results of these are shown on the new black-and-white bathymetric map of the South Atlantic, 1:40,000,000, in "Die Deutsche Atlantische Expedition auf dem *Meteor* 1925-1927: Gesammelte Expeditionsberichte," Berlin, 1927, last report, Map No. 4. This map was probably produced by contouring the soundings on German Admiralty Chart No. 384 (the South Atlantic, 1:12,000,000), edition of 1927. This chart has been used in compiling the present bathymetric map of the Antarctic. An even greater number of *Meteor* echo soundings are shown on the latest editions of the more detailed German Admiralty charts of the east coast of South America (Nos. 523, 547, 645-651, 714, 1057) and of the west coast of Africa (Nos. 382, 417, 624), but it was not possible to utilize them in preparing the first (1929) edition of our bathymetric map.

It may be appropriate to state here that since the publication of the first edition of the present map new soundings have become available in the expedition reports referred to in this booklet on the pages indicated: Discovery Research Committee since 1925, including cruise of *William Scoresby*, 1929-1930 (p. 8), Riiser-Larsen (p. 22), Mawson (p. 28), and Byrd (p. 11). When plotted, these call for modification in detail of some submarine contours as shown on the present map, but they do not alter the broad general features of submarine relief. The most striking change is the greater definition of the Kerguelen-Gaussberg Ridge.

LIST OF POLAR PUBLICATIONS OF THE AMERICAN GEOGRAPHICAL SOCIETY

SEPARATE PUBLICATIONS

- Problems of Polar Research. By thirty-one authors. 477 pp. *Special Publication No. 7*, 1928. \$5.00.
- The Geography of the Polar Regions. By Otto Nordenskjöld and Ludwig Mecking. 355 pp. *Special Publication No. 8*, 1928. \$4.00.
- Bering's Voyages. By F. A. Golder. Two volumes (not sold separately): Vol. 1, 371 pp.; Vol. 2, 290 pp. *Research Series Nos. 1 and 2*, 1922 and 1925. \$8.00.
- The Last Glaciation, With Special Reference to the Ice Retreat in North-eastern North America. By Ernst Antevs. 292 pp. *Research Series No. 17*, 1928. \$3.50.

IN THE BULLETIN OF THE AMERICAN GEOGRAPHICAL SOCIETY

(1852-1915: generally quarterly to 1903; monthly, 1904-1915. Separate numbers, if in stock, 50 cents; the volumes for the following years available at \$1.00 each: 1871, 1872, 1874, 1876, 1878-1905 inclusive, 1908, 1915.)

- E. K. Kane: Access to an Open Polar Sea Along a North American Meridian, [Vol. for] 1852-54, pp. 84-102.
- C. F. Hall: Letter to Chief Justice Daly on Geographical Discoveries in the Arctic Regions, Vol. 3, 1872, pp. 216-221.
- Report of the Reception, by the American Geographical Society, of Captain Hall and His Officers Previous to Their Departure for the Arctic Regions, Held June 26th, 1871, Vol. 3, 1872, pp. 401-415.
- John Rae: Practical Hints for Arctic Traveling, Vol. 9, 1877, pp. 149-153.
- H. W. Howgate: Plan for Exploration of the Arctic Regions, Vol. 10, 1878, pp. 279-287.
- Arctic Meeting at Chickering Hall, October 28th, 1880: Reception of Lieut. Frederick Schwatka and His Associates of the Franklin Search Party of 1878, 1879, and 1880; Addresses by Chief Justice Daly, Lieut. Frederick Schwatka, U. S. Army, and Dr. Isaac I. Hayes, Vol. 12, 1880, pp. 237-296.
- Frank Rust: The Dutch Polar Expedition of 1882-83, Vol. 15, 1883, pp. 375-380.

- Arctic Meeting at Chickering Hall, November 21st, 1884: Reception of Lieut. A. W. Greely, U. S. Army, and His Surviving Companions in the Exploration of the Arctic; Addresses by Chief Justice Daly, LL.D., Rev. Roswell D. Hitchcock, D.D., Prof. Theodore W. Dwight, Elial F. Hall, Esq., and Gen. Egbert L. Viele, Vol. 16, 1884, pp. 311-344.
- William Bradford: Life and Scenery in the Far North, Vol. 17, 1885, pp. 79-124.
- R. E. Peary: A Reconnaissance of the Greenland Inland Ice, 1886, Vol. 19, 1887, pp. 261-289.
- R. E. Peary: A Proposed Exploration of Northern Greenland: Address Before the American Geographical Society, April 13, 1891, Vol. 23, 1891, pp. 157-171.
- John Rae: Letter on Arctic Explorations, Vol. 23, 1891, pp. 194-201.
- R. E. Peary: Work in North Greenland in 1894 and 1895, Vol. 28, 1896, pp. 21-36.
- F. A. Cook: Captain Fabian Gottlieb von Bellingshausen: The Discovery of Alexander I, Peter I, and Other Islands, Vol. 33, 1901, pp. 36-41.
- R. E. Peary: Report of Work Done in the Arctic in 1898-1902, Vol. 35, 1903, pp. 496-534.
- E. S. Balch: Wilkes Land, Vol. 38, 1905, pp. 30-32.
- E. S. Balch: Stonington Antarctic Explorers, Vol. 41, 1909, pp. 473-492.
- E. S. Balch: Palmer Land, Vol. 43, 1911, pp. 282-283.
- E. S. Balch: Hudson Land (Antarctic), Vol. 43, 1911, pp. 445-446.
- Vilhjalmur Stefansson: The Technique of Arctic Winter Travel, Vol. 44, 1912, pp. 340-347.
- E. S. Balch: Antarctic Names, Vol. 44, 1912, pp. 561-581.
- Vilhjalmur Stefansson: Misconceptions About Life in the Arctic, Vol. 45, 1913, pp. 17-32.

IN THE GEOGRAPHICAL REVIEW

(1916 to date: monthly, 1916-1920; quarterly since 1921.
Monthly numbers, 50 cents each; quarterly numbers, \$1.25 each.)

- Diamond Jenness: The Copper Eskimos, Vol. 4, 1917, pp. 81-91.
- R. M. Anderson: Recent Explorations on the Canadian Arctic Coast, Vol. 4, 1917, pp. 241-266.
- H. U. Hall: A Siberian Wilderness: Native Life on the Lower Yenisei, Vol. 5, 1918, pp. 1-21.
- Diamond Jenness: The Eskimos of Northern Alaska: A Study in the Effect of Civilization, Vol. 5, 1918, pp. 89-101.
- R. J. Flaherty: The Belcher Islands of Hudson Bay: Their Discovery and Exploration, Vol. 5, 1918, pp. 433-458.
- R. J. Flaherty: Two Traverses Across Ungava Peninsula, Labrador, Vol. 6, 1918, pp. 116-132.

- M. P. Porsild: On "Savssats," A Crowding of Arctic Animals at Holes in the Sea Ice, Vol. 6, 1918, pp. 215-228.
- Vilhjalmur Stefansson: The Activities of the Canadian Arctic Expedition from October, 1916, to April, 1918, Vol. 6, 1918, pp. 354-369.
- Vilhjalmur Stefansson: "Living Off the Country" As a Method of Arctic Exploration, Vol. 7, 1919, pp. 291-310.
- R. N. Rudmose Brown: Spitsbergen, Terra Nullius, Vol. 7, 1919, pp. 311-321.
- Knud Rasmussen: The Second Thule Expedition to Northern Greenland, 1916-1918: Narrative of the Expedition, Vol. 8, 1919, pp. 116-125.
- Knud Rasmussen and others: Scientific Results of the Second Thule Expedition to Northern Greenland, 1916-1918, Vol. 8, 1919, pp. 180-187.
- Charles Rabot: The Norwegians in Spitsbergen, Vol. 8, 1919, pp. 209-226.
- Clark Wissler: Arctic Geography and Eskimo Culture: A Review of Steensby's Work, Vol. 9, 1920, pp. 125-138.
- H. L. Bridgman: Peary: An Appreciation, Vol. 9, 1920, pp. 161-169.
- Vilhjalmur Stefansson: The Region of Maximum Inaccessibility in the Arctic, Vol. 10, 1920, pp. 167-172.
- M. P. Porsild: On Eskimo Stone Rows in Greenland Formerly Supposed To Be of Norse Origin, Vol. 10, 1920, pp. 297-309.
- E. M. Kindle: Mackenzie River Driftwood, Vol. 11, 1921, pp. 50-53.
- Vilhjalmur Stefansson: Plover Land and Borden Land, Vol. 11, 1921, pp. 283-291.
- Diamond Jenness: The Cultural Transformation of the Copper Eskimo, Vol. 11, 1921, pp. 541-550.
- Diamond Jenness: Eskimo Art, Vol. 12, 1922, pp. 161-174.
- Vilhjalmur Stefansson: Some Erroneous Ideas of Arctic Geography, Vol. 12, 1922, pp. 264-277.
- Olaf Holtedahl: Novaya Zemlya, A Russian Arctic Land, Vol. 12, 1922, pp. 521-531.
- Diamond Jenness: Origin of the Copper Eskimos and Their Copper Culture, Vol. 13, 1923, pp. 540-551.
- J. W. Harshberger: The Gardens of the Faeroes, Iceland, and Greenland, Vol. 14, 1924, pp. 404-415.
- H. F. Reid: Antarctic Glaciers, Vol. 14, 1924, pp. 603-614.
- A. H. Brooks: The Value of Alaska, Vol. 15, 1925, pp. 25-50.
- P. S. Smith: Explorations in Northwestern Alaska, Vol. 15, 1925, pp. 237-254.
- N. A. Transehe: The Siberian Sea Road: The Work of the Russian Hydrographical Expedition to the Arctic, 1910-1915, Vol. 15, 1925, pp. 367-398.

- Diamond Jenness: *A New Eskimo Culture in Hudson Bay*, Vol. 15, 1925, pp. 428-437.
- Knud Rasmussen and others: *The Danish Ethnographic and Geographic Expedition to Arctic America: Preliminary Report of the Fifth Thule Expedition*, Vol. 15, 1925, pp. 521-562.
- William Hovgaard: *The Norsemen in Greenland: Recent Discoveries at Herjolfsnes*, Vol. 15, 1925, pp. 605-616.
- Lauge Koch: *The Question of Peary Channel*, Vol. 15, 1925, pp. 643-649.
- E. S. Balch: *The First Sighting of West Antarctica*, Vol. 15, 1925, pp. 650-653.
- Lauge Koch: *Ice Cap and Sea Ice in North Greenland*, Vol. 16, 1926, pp. 98-107.
- W. H. Hobbs: *The University of Michigan Greenland Expedition of 1926-1927*, Vol. 16, 1926, pp. 256-263.
- W. H. Hobbs: *The First Greenland Expedition of the University of Michigan*, Vol. 17, 1927, pp. 1-35.
- Ejnar Mikkelsen: *The Colonization of Eastern Greenland: Eskimo Settlement on Scoresby Sound*, Vol. 17, 1927, pp. 207-225.
- R. H. Woodworth: *Notes on the Torngat Region of Northern Labrador*, Vol. 17, 1927, pp. 632-642.
- G. P. Putnam: *The Putnam Baffin Island Expedition*, Vol. 18, 1928, pp. 1-40.
- Sir Hubert Wilkins: *The Flight from Alaska to Spitsbergen, 1928, and the Preliminary Flights of 1926 and 1927*, Vol. 18, 1928, pp. 527-555.
- Sir Napier Shaw: *Arctic Weather of April 15-16, 1928, with Some Observations on Polar Weather in Relation to the General Circulation*, Vol. 18, 1928, pp. 556-566.
- Diamond Jenness: *Little Diomedede Island, Bering Strait*, Vol. 19, 1929, pp. 78-86.
- Otto Pettersson: *Changes in the Oceanic Circulation and Their Climatic Consequences*, Vol. 19, 1929, pp. 121-131.
- Gunnar Isachsen: *Peary's Marches on His North Pole Expedition, 1909*, Vol. 19, 1929, pp. 132-134.
- Sir Hubert Wilkins: *The Wilkins-Hearst Antarctic Expedition, 1928-1929*, Vol. 19, 1929, pp. 353-376.
- H. R. Mill: *The Significance of Sir Hubert Wilkins' Antarctic Flights*, Vol. 19, 1929, pp. 377-386.
- Gunnar Isachsen: *Modern Norwegian Whaling in the Antarctic*, Vol. 19, 1929, pp. 387-403.
- H. A. Innis: *The Hudson Bay Railway*, Vol. 20, 1930, pp. 1-30.
- Sir Hubert Wilkins: *Further Antarctic Explorations*, Vol. 20, 1930, pp. 357-388.

- J. B. Charcot: "Charcot Land", 1910 and 1930, Vol. 20, 1930, pp. 389-396.
- J. D. Soper: Explorations in Foxe Peninsula and Along the West Coast of Baffin Island, Vol. 20, 1930, pp. 397-424.
- E. P. Wheeler, 2nd: Journeys About Nain: Winter Hunting With the Labrador Eskimo, Vol. 20, 1930, pp. 454-468.
- Sir Douglas Mawson: The Antarctic Cruise of the "Discovery", Vol. 20, 1930, pp. 536-554.
- Hjalmar Riiser-Larsen: The "Norvegia" Antarctic Expedition of 1929-1930, Vol. 20, 1930, pp. 555-573.

SEPARATE MAPS

- South Polar Chart, 1:40,000,000. 1905. [Out of stock.]
- Map of Eastern Labrador. By Mrs. Leonidas Hubbard, Jr. 1:1,584,000. 1906. 25 cents.
- Map of the Arctic Regions. Prepared in coöperation with the American Museum of Natural History. 1:6,300,000. 1912. [Out of stock.]
- Map of Alaska. Prepared in coöperation with the Alaska Road Commission. 1:1,250,000. 2 sheets. Unmounted, \$2.00 (postage, 25 cents); mounted, \$5.00 (postage, 50 cents).
- The Belcher Islands. From plans and sketches of Robert J. Flaherty. 1:1,500,000. 1918. 25 cents.
- Two Route Surveys Across Ungava Peninsula, Labrador: (1) via the Povungnituk and Payne Rivers; (2) via Lake Minto and Leaf River. By Robert J. Flaherty. 8 miles to 1 inch (1:506,880), with inset, 1:3,150,000, of Ungava Peninsula incorporating the latest sources. 1918. 25 cents.
- Map of Alaska: Land Classification and Fisheries; Transportation and Water Power; Distribution of Mineral Deposits. By Alfred H. Brooks. 1:10,000,000. 1925. 25 cents.
- Map of the Russian Hydrographical Expedition to the Arctic. 1:8,500,000. 1925. 25 cents.
- Preliminary Map of the Territories Mapped by the Fifth Thule Expedition. By Peter Freuchen and Therkel Mathiassen. 1:4,000,000. 1925. 25 cents.
- Map of the Graham Land Region, Incorporating the Discoveries Made by Sir Hubert Wilkins on His Flight of Dec. 20, 1928. 1:6,000,000. 25 cents.
- Map Showing the Field of Operations of the Wilkins-Hearst Antarctic Expedition During the Season of 1929-1930. 1:6,000,000. 1930. 25 cents.
- Reconnaissance Map of the Labrador Coast in the Vicinity of Nain. 1:500,000. 1929. 25 cents.

- British, Australian, and New Zealand Antarctic Research Expedition, Sir Douglas Mawson, in command: (a) Map Showing the Field of Operations During the Season of 1929-1930, 1:25,000,000; (b) Map Showing the Discoveries of the Expedition Along the Coast of the Antarctic Continent Between 49° and 81° E., 1:6,000,000. 1930. 25 cents.
- "Norvegia" Antarctic Expedition of 1929-1930, Commander H. Riiser-Larsen, in command: Map Showing the Field of Operations of the Expedition, 1:25,000,000, with two inset maps showing the New Lands Discovered by the Expedition, 1:6,000,000. 1930. 25 cents.
- Map of the Antarctic [within the 63rd parallel], 1:4,000,000, in four sheets. Printed in two colors. Accompanied by a Navigational Chart of the Antarctic, 1:12,000,000, and a descriptive pamphlet. 1928. \$5.00.
- Map of the Antarctic [showing the relation to the Southern continents], 1:12,500,000, with an inset Map of the Antarctic Archipelago, 1:2,500,000, and ten photographs. With "Explanatory Booklet to Accompany a Map of the Antarctic." 1929. \$5.00.

